AD

432l2

RB-54-7

A FACTOR ANALYSIS OF MEMORY ABILITY

H. Paul Kelley

(Ph.D. Thesis, Princeton University, 1954)

Educational Testing Service

Princeton, New Jersey

April, 1954

A FACTOR ANALYSIS OF MEMORY ABILITY

Λ Technical Report

prepared by

H. PAUL KELLEY

Princeton University

and

Educational Testing Service

April 1954

A FACTOR ANALYSIS OF MEMORY ABILITY

Abstract

The purpose of this study is to investigate the area in the memory domain concerning relatively immediate intentional retention. For memory tests limited to this area, is there a general memory factor; if not, can several distinct memory factors be identified?

On the basis of hypotheses regarding the nature of four memory factors, a battery of 27 memory tests was constructed. These tests, together with 13 reference tests, were administered to 442 pilot cadets at Lackland Air Force Base, San Antonio, Texas. The scores on the 40 tests were then intercorrelated and factor-analyzed. The multiple-grouping method of analysis was used, with the solution being iterated twice; the resulting factor matrix was then rotated to oblique simple structure.

Eleven factors were found, three of which are rather clearly-defined memory factors; they may be called Rote Memory, Meaningful Memory, and Span Memory. The reference tests clearly identify three other factors as Verbal Comprehension, Numerical Facility, and Perceptual Speed. The seventh factor is a doublet representing the specific variance of two parallel tests. The eighth factor is a triplet which cannot be positively identified. The remaining three factors all primarily seem to involve visual tasks. These factors seem to represent Visualization, Spatial Relations, and Visual Memory, but the identifications are uncertain since there seems to be confounding with Deductive Reasoning and Psychomotor Coordination.

It has been established that in the area of immediate intentional retention there is no general factor; three distinct factors in this domain were clearly identified, while still others were suggested. The three memory factors found seem to be differentiated in terms of process rather than in terms of content or mode of presentation.

A FACTOR ANALYSIS OF MEMORY ABILITY

by

H. Paul Kelley

Princeton, 1954

A DISSERTATION

PRESENTED TO THE

FACULTY OF PRINCETON UNIVERSITY

IN CANDIDACY FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

RECOMMENDED FOR ACCEPTANCE BY THE

DEPARTMENT OF PSYCHOLOGY

April, 1954

ACKNOWLEDGMENTS

ing of the experimental tests and to the Office of Naval Research for its support of the analysis of the data for this research project. Most of this research was carried out while I was a Psychometric Fellow at the Educational Testing Service.

H. Paul Kelley

Princeton, New Jersey

April 30, 1954

A FACTOR ANALYSIS OF MEMORY ABILITY

Table of Contents

Table of Contents

List of Tables

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

Chapter I

DEFINITION OF THE PROBLEM

A. Introduction

One of the purposes of psychology is to attempt to understand and account for observable individual differences in behavior in terms of a limited number of concepts or ideal constructs. The names given to these constructs are unimportant; historically, some of them have been termed "abilities." Accepting this terminology, one can consider abilities as being, in a sense, determiners of behavior, in that the presence of an ability in an individual enables him to perform some task successfully, while the absence of that ability renders the performance of that task unsuccessful. It also may be considered that an individual's performance on a task or "test" is determined in part by the abilities that are called for by the test and in part by the degree to which the individual himself possesses these abilities. It is desirable that the definitions of these constructs or abilities be based on behaviors and relations between behaviors which can be observed experimentally.

With acceptance of the model established by these definitions it becomes necessary to find some method for analysis of the observed test-performance into the two components indicated above. The methods of factor analysis have been developed as a refined technique for the study of individual differences so as to obtain a measure of the extent to which each ability is called for by each test; the factor "loadings" which are obtained from the analysis are such numerical measures. It is to be noted that in factor analysis, as in all other methods for

the investigation of individual differences, two abilities will be differentiated from each other only when (a) there is fairly wide variation of both abilities from subject to subject in the population being measured, (b) the degree of correlation between these two abilities is fairly low in the population being tested, and (c) measures of tests are being used which depend to different degrees upon each of the two abilities. These points are discussed by Thurstone (61, pp. 51-67).

The factor analysis itself will not identify the nature of the abilities revealed; this identification remains the problem of the psychologist. How then is the nature of each of these abilities which the factor analysis distinguishes to be determined? In order to identify a factor one must look at all the tests with high loadings on that factor and, keeping in mind the tests with no loadings on it, then try to infer the nature of the process underlying or identifying the factor.

If an ability model such as is presented above is to be used to describe behavior, the question arises as to the number and nature of abilities which are necessary to account for human behavior. For convenience, behavior may be roughly classified into certain groups, or domains, such as the memory domain or the reasoning domain. Since much, if not most, human behavior involves memory of one kind or another, it becomes important to know the factorial structure of the memory domain. The simplest possible structure that could exist would be a general factor of memory, i.e., memory would be a unitary trait. Is this true? It seems very unlikely both on the basis of one's own personal experience and on the basis of past psychological experimentation. The following questions may then be raised: Is the memory function differentiated for the several modalities of presentation? Does

immediate memory involve the same ability as that involved in the memory of past experience even when the subject makes no special effort to remember the experience? Is relatively immediate intentional retention a unitary trait; if not, how does it vary—e.g., with content or type of material, mode of presentation, modality of presentation, psychological processes involved?

B. Review of the Literature

What light has been shed on the problem of memory ability or abilities by previous research? In summarizing the relevant evidence it is convenient to divide the literature into three classes: non-correlational studies, correlational studies, and factor-analytic studies.

1. Non-correlational studies.

Typical findings include the following:

In memorizing, some subjects make use of visual imagery while others use auditory imagery. The power of recalling the memory-image varies with different persons (30).

Transfer studies in general yield no evidence to support the hypothesis of a general memory function; there is no general memory improvement as a result of practice. Some of the variables which affect the amount of transfer are: kind of material, method of procedure, imagery, and logical organization of the material (53).

Some subjects learn faster by auditory presentation while others learn faster by visual presentation. However, in general, subjects who learn easily by one method also learn easily by the other (76).

2. Correlational studies.

Typical findings include the following:

In general, the correlations between memory tests are positive, but many of these correlations are quite low (26, 49).

There is evidence which tends to indicate that memory ability is specific for different types of material learned (2, 37).

Within the same type of material, high correlations exist between scores on visually-presented and scores on auditorily-presented tests (7, 31). (Both of these studies are deficient in that very few subjects were used.)

The evidence regarding recall vs. recognition is conflicting. Some investigators feel that differences in type of content cause less fluctuation than do differences in testing methods, while other investigators feel that the material to be learned is more important than the method of testing retention (49).

The indication is fairly clear that different factors are operating in substance and rote memory. When material and procedure are held constant, the correlations between memorizing ideas and memorizing exact words is still low. The correlation between immediate recall for related and unrelated material is also low (29, 39, 71).

The evidence regarding memory span is conflicting. These studies do not make clear the extent to which memory span is general or specific for type of material and for modality of presentation (8).

Correlations between memory tests and aptitude tests depend to some extent upon the content to be memorized (67).

3. Factor-analytic studies.

For convenience these studies may be divided into general-factor studies and multiple-factor studies; this division is made in terms of the method of factor analysis used.

a. General-factor studies.

In summarizing the results of general-factor studies up to 1927, Spearman (54) came to the following conclusions:

(1) The correlations between memory tests are not accounted for by "g" factor alone.

(2) There seems to be a distinction between logical and rote memory in that "g" is present in the former and absent in the latter.

(3) There seems to be a group factor of memory, but it is very small.

(4) Carey (13, 14) found a sensory-memory group factor which was common to tests presented both visually and auditorily. (All material was non-verbal.)

(5) Both Abelson (1) and Carothers (16) found a group factor in verbal memories.

(6) Krueger and Spearman (47) found a group factor in non-verbal symbolic memories.

(7) No group factors were found to distinguish between immediate and delayed memory or between recall and recognition.

(8) Spearman stated by way of general conclusion: "When two kinds of memory resemble each other only in the bare fact of both involving retentivity, the correlation arising from this cause is little if at all above zero. In proportion as the

likeness between them is augmented by resemblance of material—
for instance, by both being sensory, or by both being verbal—
the correlation becomes more marked." (54, p. 290.)

Truman L. Kelley (44) reported a single group-factor of memory.
However, only four memory tests were included in his battery of nine
tests, and these four tests were very similar in nature. Kelley states
that, "The claim that one is possessed of 'memories' rather than a
'memory ability' would seem not to be fully justified. There, of
course, must be memories dependent upon the material involved, but the
readiness with which this material can be memorized would seem to be
general." (44, p. 108.) He further recommends, however, that this
conclusion be tested in additional studies by memory tests which differ
from each other more radically than did the four tests used by him.

Garrett (24) reported three group-factors, but since the descrip-
tions of his tests are so inadequate, only the Number-Span Factor can
be identified. He was not interested in identifying these group fac-
tors; rather, he dropped all but one test from each group and then
found a common general factor. He tentatively suggests that this is a
general memory factor rather than being "g." A reanalysis, by the
author, of Garrett's memory-test data by multiple-factor techniques
revealed three factors which might perhaps be identified as Span Memory,
Meaningful Memory, and Rote Memory. For the reason given above, the
identifications of the last two factors are only very tentative.

Anastasi (3) reported a small general memory factor; however, no
memory span tests were included in her battery. Later (4), however,
she concluded that the common factor previously found was not a
general memory factor and that a common factor in memory tests seemed

defined as memory for a certain type of material rather than memory tested by some one method. In fact, she suggested that the common factor previously found could have represented special devices for the rote memorization of verbal material.

Bolton (9) tentatively concluded that memory is not a unitary trait, but he made no attempt to identify the nature of the several group factors.

Holzinger, Harman, and Swineford (33, 34, 35, 56) reported the appearance of a memory group factor in several of their bi-factor studies. However, the tests used in the various studies did not overlap in such a way as to show that the group factor found was always the same factor. An examination of the tests indicates that in one study (33) perhaps the group factor might be Span Memory, while in other studies (35, 56) it might be Rote Memory.

Vernon (68) rejected the idea of a unitary group factor for memory. "Probably there exist several small group factors, each representing memory for a certain narrow range of material. In other words, there may be several different types, but no single entity, of memory." (68, pp. 152-153.) Later (69, p. 49) Vernon stated that rote memorizing was the only substantiated memory faculty.

Eysenck and Halstead (20) concluded that there was not even a general memory factor in their test battery, much less several group memory factors. They contended that all fifteen memory tests in their battery were measuring only the "g" factor of general intelligence, and that if there was a general factor of memory, "...no assessment of memory ability is possible by the use of the tests examined." (20, p. 178.) However, Vernon (69) stated that this result was due, at

least in part, to the unusual heterogeneity of the subjects in "g."
Hence, since this study is based on only 60 subjects, and since the re-
sults are in clear opposition to virtually all current results of other
investigators, this conclusion cannot be accepted without further ex-
perimental support.

Spearman and Jones (55) give a general summary of this work in
their chapter on retentivity and memory. These authors feel that there
has been "...an almost universal deficiency in factorization of memory
...in that the field is liable to be (so) greatly extended that little,
if any, of it is covered adequately." (55, p. 178.)

b. Multiple-factor studies.

Wolfle (74), in his review of factor analysis studies, reported
that a memory factor was the fourth most frequently identified factor.
He stated that it is best tested by paired association or recognition
tests of recently learned material and that perhaps it might better be
called rote learning or immediate memory. Both Anastasi (3, 4; see
above) and Carlson (15; see below) reported several memory factors,
but the identifications seemed inadequate.

Bryan (12) studied the memory ability of young children. She re-
ported a general memory factor throughout her battery of ten memory
tests; a vocabulary test and the Stanford-Binet Intelligence Test also
were high on this general factor. A second factor was interpreted as
a doublet factor between two span memory tests, while a third factor
was not interpreted. It seems clear from her report, however, that no
effort was made to rotate the axes to psychologically-meaningful posi-
tions before the factors were interpreted.

Garrett (25) reanalyzed Bryan's data, omitting the intelligence test from the battery. He extracted four factors and rotated the axes orthogonally before making his interpretations. He identified two of the factors as Memory and Sequences, while the other two he only very tentatively identified as Verbal Expression and Manipulation. The vocabulary test appeared with only a low loading on the Memory factor; its highest loading was on the Verbal Expression factor. Although the results were far from clear-cut, Garrett felt that his result "...probably substantiates Bryan's claim for a general memory factor through her tests..." (25, p. 289).

Garrett (25) also reanalyzed two of the sets of data reported by Anastasi (3, 4), whose results have been summarized above. In reanalyzing the data from (3), Garrett reported four orthogonal factors which he called Memory, Word, Number, and Form. In his reanalysis of the first set of data from (4), Garrett reported three oblique factors which he called Number, Memory, and Verbal; the Number and Verbal factors were correlated .24, but the Memory factor was uncorrelated with either of them. He concluded that the reanalyses had verified Anastasi's finding that in adult groups memory is independent of verbal and number abilities. In both these analyses, the Memory factor seems to represent some sort of rote memory for unrelated material; Garrett did not reanalyze the data which led Anastasi to the conclusion that there is no single common memory factor.

Carlson (15) studied immediate memory for words. He anticipated three factors: Visual Rote Memory, Vocal and/or Subvocal Rote Memory, and Logical Memory. However, all material was presented visually and only recognition tests were used. Eight factors were found, but

the interpretations were too equivocal to establish or refute the hypotheses. Carlson's interpretations of the factors were: a general memory factor, three visual memory factors instead of only one, a meaningful memory factor, and three uninterpretable factors. Weaknesses in this study include lack of reference tests and experimental dependence between tests.

Thurstone (58, 59) reported a memory factor as one of his primary mental abilities; this factor seems to represent Rote Memory, including both recall and recognition tests.

Woodrow (75) reported a memory factor which probably is Span Memory, although it might be Rote Memory.

Brener (10) factor-analyzed a battery of ten memory span tests. All tests were presented either visually or else visually and auditorily simultaneously. The material used included geometrical designs, colors, digits, consonants, nonsense syllables, words, and sentences. He reported a general factor and three group factors; he identified the general factor as Memory Span and the group factors as Verbal, Visual or Spatial Imagery, and Speed of Reading or Speed of Apprehension. The identifications are not clear, due to lack of reference tests and the small number of tests in the battery.

Karlin (40, 41) investigated the factorial structure of auditory function. In his early analysis of only auditory tests (40), he identified three factors as Retentivity or Memory for Elements, Tonal Sensitivity, and Memory for Form. In his later analysis (41) he reported eight identifiable factors, three of which were related to memory. He distinguished between a General Span Factor, which was independent of sense modality, and an Auditory Span Formation Factor, which "...is

not a memory factor primarily." (41, p. 270.) Karlin did not use any
of the types of tests ordinarily used to measure memory span, and it
is somewhat unclear just how such tests administered auditorily would
fit into this type of structure. Another factor, which transcended
sense modality, was identified as Incidental Closure; the tests with
large projections on this factor all involved recall of the completion
type. These studies still leave unanswered the question as to how these
auditory tests are related factorially to other more common types of
memory tests.

On the basis of several analyses, the U. S. Army Air Force (27)
reported three memory factors. Regarding M_1, Paired-Associates Memory,
the Air Force stated that, "It is involved in tasks requiring memoriza-
tion of items in pairs, and is evaluated by an immediate test of re-
tention and recognition." (27, p. 823.) About M_2, Visual-Memory, they
stated, "It is prominent in tests requiring the retention and recall of
a pictorial stimulus after very short time intervals. The length of
time interval may be an irrelevant condition in this as in factor M_1."
(27, p. 823.) Factor M_3 was not given an identifying title; the state-
ment was made that, "This memory factor seems to be restricted to
memorizing paired-associates material in which one item is a pictorial
symbol and the other is a verbal symbol." (27, p. 823.)

Thurstone considered the problems of memory factors in a number
of reports from his University of Chicago Psychometric Laboratory (60,
62, 63, 64). He stated that three memory factors had been isolated.
Factor M_1 he identified as representing the ability to learn paired
associates; this factor "...seems to transcend the nature of the con-
tent so that it is applicable to numerical, verbal, or visual material."

(60, p. 6.) Factor M_2 was thought to be associated with incidental memory, and factor M_3 seemed to represent the ability to keep in mind some perceptual detail. In addition to these three factors, Thurstone felt that, "There is good indication that auditory memory is not the same ability as visual memory." (62, p. 2.) He also stated that there is an indication of another memory factor "...that may be concerned with memory for temporal sequences as distinct from paired associations." (60, p. 6.)

Jones (38), in another study from Thurstone's Psychometric Laboratory at the University of Chicago, found two memory factors. Factor D he interpreted as a memory span factor, representing "...the ability to reproduce, immediately after presentation, a sequence of disconnected elements"; he felt it likely that "...the process underlying memory span performance differs from that required for the memory of paired associates." (38, p. 6.) Factor E was tentatively identified as representing "...an ability for verbatim recall of meaningful verbal material." (38, p. 7.)

Rimoldi (51) factor-analyzed a battery of nineteen non-verbal tests obtaining five identifiable factors. One of these factors, which he identified as a memory factor, seemed to be measured primarily by memory span tests.

Zimmerman (78) re-rotated the factor matrix from Thurstone's Primary Mental Abilities study (58). He reported two memory factors, Rote Memory and Memory for Observed Relationships, instead of the single memory factor found by Thurstone. The Memory for Observed Relationships factor was only very tentatively identified, with the suggestion that perhaps it is memory for ideas as opposed to rote memory.

French (21), in his survey and summary of factor studies, suggested four memory factors which he termed Associative or Rote Memory, Musical Memory, Span Memory, and Visual Memory. In the light of the studies reviewed, French raised the following questions:

(1) Is Span Memory distinct from Rote Memory? Both factors have never appeared in a single study.

(2) Will Rote Memory break into two factors, recall and recognition? This seems unlikely, but the evidence is unclear.

(3) Is Musical Memory distinct from Rote Memory? (The further question might be raised as to whether this factor is restricted to music or whether it might not instead be common to a larger class of auditory tasks.)

(4) What is the nature of Visual Memory? The evidence for the factor is very thin, though it seems clearly separate from Rote Memory.

c. Evaluation and criticisms of factor studies.

In general there seem to be three main points of weakness in previous factor studies in the domain of memory ability. The first weakness which might be pointed out is that many studies are too narrow to reveal the extent of and interdependencies among the different factors in the memory domain; the studies have used too few memory tests, i.e., the sample of types of memory tasks was too small to clearly delimit the factors. This narrowness is largely due to the fact that most of the studies were primarily concerned with problems in domains other than that of memory.

A second point of weakness which has been fairly common regards the matter of experimental dependence among tests in the test battery.

Thurstone (61) has shown that when tests in a battery are experimentally dependent upon one another, the factor structure is seriously disturbed, with extra factors being added to the structure. Since such an extra factor usually involves only a very small number of tests, the rotational and interpretational problems are made much more complex, especially if there are several such factors in a single study.

The third weakness which may be mentioned is the lack of reference tests in some of the analyses; when such tests are omitted from the analysis, the rotation of the factors to meaningful positions and their subsequent interpretation is rendered more difficult and questionable.

d. Unanswered questions.

Of the many questions which have been raised by the studies discussed above, this study will seek to find answers to the following:

(1) Is Rote Memory a distinct, separate factor?

(2) Is Meaningful Memory a distinct, separate factor?

(3) Is Span Memory a distinct, separate factor?

(4) Are each of these three factors independent of the modality of presentation of the test material?

(5) Are each of these three factors independent of the type of test material used?

(6) Is Visual Memory a distinct, separate factor?

(7) Are each of these four factors independent of the method used in testing retention?

C. Hypotheses To Be Tested

In order to obtain some information pertinent to the answering of the above questions, the nature of four memory factors was postulated as follows:

1. <u>Rote Memory</u>. The ability to recall learned meaningless material.

2. <u>Meaningful Memory</u>. The ability to recall learned meaningful material.

3. <u>Span Memory</u>. The ability to recall perfectly a series of unrelated items after only one presentation of the series.

4. <u>Visual Memory</u>. The ability to recall material learned by the formation of an image of a whole visual field.

Additional factors might be postulated, such as Auditory Memory (of one or more types) and Incidental Memory (of one or more types), but no attempt will be made to investigate such factors in this study.

On the basis of the four hypotheses formulated above, a battery of memory tests was constructed by the author. Each test was intended to measure primarily one of these four factors, with an attempt being made to vary the task as much as possible within the limits of the stated hypotheses. Both visually-presented and auditorily-presented span tests were included in the battery. Although no Auditory Memory Factor was expected in this battery, several auditorily-presented non-span tests were included in order that such a factor might be identified if it should appear. Both verbal and non-verbal tests were constructed in the attempt to measure Meaningful Memory. Answer types included primarily the traditional recall and recognition types, to-

gether with some true-false and multiple-choice items. The tests will
be described in detail in the following chapter.

Chapter II

DESCRIPTION OF THE TEST BATTERY

The descriptions of the experimental tests below are divided into groups in terms of the factor of which each test was designed to be primarily a measure. The tests were numbered consecutively in the order in which they were administered; this administration number is given preceding the title of the test. Appendix A contains the directions pages for each test, arranged in order of administration; in almost every case these directions contain sample problems. All of the memory tests used in this study were administered as group tests.

A. Rote Memory Tests

7. Recognition Test I. (Syllables)

Type of task: The examinee must indicate for each syllable in the test list whether or not that syllable was in the list of syllables which he studied previously.

Number of items: 18 syllables to be recognized from list of 36.

Time: 1 minute study time.

Score: Number correct.

17. Recognition Test II. (Words)

Type of task: The examinee must indicate for each word in the test list whether or not that word was in the list of words which he heard previously. The words used are two-syllable nouns which are unrelated to each other.

Number of items: 25 words to be recognized from list of 50.

17

Time: Words read aloud at rate of approximately 2 seconds each.

Score: Number correct.

23. Recognition Test III. (Figures)

Type of task: The examinee must indicate for each geometrical figure or symbol in the test group whether or not that figure was in the group of figures which he studied previously.

Number of items: 40 figures to be recognized from group of 80.

Time: 1 minute study time.

Score: Number correct.

3. Memory for Syllables Test I.

Type of task: The examinee must learn pairs of nonsense syllables so that when he is presented with the first syllable of a pair he can reproduce the second syllable.

Number of items: 2 parts, administered consecutively; 6 pairs per part.

Time: 1 minute study time for each part.

Score: Number correct.

22. Memory for Syllables Test II.

Type of task: This test is a parallel form of test 3, Memory for Syllables Test I, using different nonsense syllables. The examinee must learn pairs of nonsense syllables so that when he is presented with the first syllable of a pair he can reproduce the second syllable.

Number of items: 2 parts, administered consecutively; 6 pairs per part.

Time: 1 minute study time for each part.

Score: Number correct.

18. Memory for Numbers Test.

Type of task: The examinee must learn pairs of words and numbers so that when he is presented with the word of a pair he can reproduce the number.

Number of items: 2 parts, administered consecutively; 12 word-number pairs per part.

Time: 1 minute study time for each part.

Score: Number correct. (Owing to an error in the preparation of the test, the first part had only 10 possible correct answers, so the total possible score was 22 rather than 24.)

6. Memory for Words Test I. (Unrelated words)

Type of task: The examinee must learn pairs of unrelated one-syllable nouns so that when he is presented with the first word of a pair he can reproduce the second word.

Number of items: 2 parts, administered consecutively; 10 pairs per part.

Time: Pairs read aloud twice at rate of approximately 2 seconds per pair, then first word of each pair read, allowing ample time for recording of responses.

Score: Number correct.

B. Meaningful Memory Tests

27. Memory for Words Test II. (Related words)

Type of task: The examinee must learn pairs of related nouns so that when he is presented with the first word of a pair he can reproduce the second word.

Number of items: 2 parts, administered consecutively; 25 pairs per part.

Time: 45 seconds study time for each part.

Score: Number correct.

25. Sentence Completion Test.

Type of task: The examinee must learn a group of unrelated sentences so that when he is presented with a sentence with one word omitted he can reproduce the missing word. When studying the sentence, the examinee does not know which word will be omitted.

Number of items: 40 sentences.

Time: 4 minutes study time, then delay of approximately 10 minutes (during which test 26, Memory for Instructions Test, is administered) before testing.

Score: Number correct.

24. Memory for Relations Test.

Type of task: The examinee must learn a group of 3 x 3 progressive matrices of varied content (including letters, numbers, names of months, and geometrical designs) so that when he is presented with the upper left-hand cell of a matrix he can reproduce whichever of the other cells is called for. (Actually, only cells 5, 6, 8, and 9 were required as responses; cells 2, 3, 4, and 7 were not tested.)

Number of items: 14 matrices.

Time: 6 minutes study time.

Score: Number correct.

4. Consequences Test I. (Non-verbal)

Type of task: The examinee is presented with several pairs of cartoon-type sketches, each pair being the first two panels of a three-panel sequence. After studying these pairs, the examinee is then presented with only the first picture of each sequence, and he must select from three choices the third picture which correctly completes that sequence.

    Number of items: 18 sequences.

    Time: 1 minute study time.

    Score: Number correct.

16. Consequences Test II. (Verbal)

Type of task: The examinee hears several pairs of sentences read aloud; the first sentence in each pair states a condition and the second sentence of the pair states a consequence of that condition. When the first sentence of each pair is read again, the examinee must correctly reproduce in his own words the consequence to that condition.

    Number of items: 20 pairs of sentences.

    Time: Approximately 2.5 minutes reading time for the 20 pairs.

    Score: Number of ideas correct.

1. Memory for Limericks Test.

Type of task: The examinee must learn a group of limericks so that when he is presented with the first four lines of a limerick he can correctly reproduce the idea and key words of the fifth line.

    Number of items: 30 limericks.

    Time: 5 minutes study time.

    Score: Number of key ideas correct.

<u>8. Memory for Ideas Test</u>.

Type of task: After hearing a brief, one-paragraph story, "The Marble Statue," the examine must reproduce it in his own words. (See <u>11</u>, p. 81.)

Number of items: 67 idea-units.

Time: Approximately 50 seconds reading time for the story.

Score: Number of idea-units reproduced.

C. Span Memory Tests

<u>5. Number Span Test I. (Auditory)</u>

Type of task: After hearing a sequence of digits, the examinee must reproduce the sequence. The sequences range in length from four to twelve digits.

Number of items: 2 sequences of each length, making 18 sequences in all.

Time: Approximately 1 second per digit reading time.

Score: Number of sequences completely correct.

<u>10. Number Span Test II. (Visual)</u>

Type of task: After seeing a sequence of digits, the examinee must reproduce the sequence. The sequences range in length from four to twelve digits. Each sequence is presented one digit at a time by flash cards on a display stand.

Number of items: 2 sequences of each length, making 18 sequences in all.

Time: Approximately 1.5 - 2.0 seconds per digit display time.

Score: Number of sequences completely correct.

2. Letter Span Test I. (Visual)

Type of task: After seeing a sequence of letters, the examinee must reproduce the sequence. The sequences range in length from three to eleven letters. Each sequence is presented one letter at a time by flash cards on a display stand.

Number of items: 2 sequences of each length, making 18 sequences in all.

Time: Approximately 1.5 - 2.0 seconds per letter display time.

Score: Number of sequences completely correct.

14. Letter Span Test II. (Auditory)

Type of task: After hearing a sequence of letters, the examinee must reproduce the sequence. The sequences range in length from three to eleven letters.

Number of items: 2 sequences of each length, making 18 sequences in all.

Time: Approximately 1 second per letter reading time.

Score: Number of sequences completely correct.

21. Sentence Span Test.

Type of task: After hearing a sentence, the examinee must reproduce it. The sentences range in length from 18 to 33 syllables.

Number of items: 16 sentences.

Time: 3.0 - 6.5 seconds reading time per sentence, depending on length of sentence.

Score: Number of sentences completely correct.

26. Memory for Instructions Test.

Type of task: After hearing a set of instructions (e.g., "Check the 9. Cross out the R."), the examinee must carry out the instructions. The sets range in length from two to five instructions.

Number of items: 16 sets of instructions.

Time: Approximately 1.5 seconds per instruction reading time.

Score: Number of sets of instructions performed completely correctly.

D. Visual Memory Tests

15. Reproduction of Visual Designs Test.

Type of task: After seeing a geometric design on a flash card, the examinee must reproduce that design.

Number of items: 10 designs.

Time: 5 seconds display time for each design.

Score: 2 points for each correct design, 1 point for each design with only minor deviations from the correct design.

9. Map Memory Test I. (Reproduction)

Type of task: After studying a product-type map of a fictional country, the examinee must reproduce the map.

Number of items: ,1 features.

Time: 2 minutes study time.

Score: In general, 1 point for presence of each feature, and 1 point for the correct location of that feature; total possible score was 56. Full credit was given if a name was reproduced instead of a symbol.

19. Map Memory Test II. (Verbal recall)

Type of task: After studying a map of a section of town and countryside, the examinee must answer multiple choice questions about the area portrayed by the map.

Number of items: 14 questions.

Time: 30 seconds study time.

Score: Number correct.

20. Map Memory Test III. (Recognition)

Type of task: The examinee must learn the map of an area of countryside so that when he is presented with five representations of a section of that map he can indicate which is the correct representation.

Number of items: 12 five-choice items.

Time: 3 minutes study time.

Score: Number correct.

E. Special Tests

11, 12, 13. Meaningful Memory: Picture, Paragraph, Number.

Type of task: This test is divided into three sections; each section is scored separately, hence the sections will be treated as three separate tests. In the Picture section, the examinee must learn the details of a sketch representing a Venetian scene so that when he is presented with a sketch of another similar Venetian scene he can answer true-false questions about the similarities and differences of the two pictures. In the Paragraph section, the examinee must learn a long encyclopedia-type article about a country so that he can answer true-false questions about it. In the Number section, the examinee

must learn detailed information about inventories in two stores so that he can answer multiple-choice questions about it.

Number of items: Picture section, 30 true-false items; Paragraph section, 30 true-false items; Number section, 15 five-choice items.

Time: 15 minutes study time, 5 minutes for each section; then delay of approximately 20-24 minutes (during which are administered tests 14, Letter Span Test II, and 15, Reproduction of Visual Designs); then 15 minutes testing time, 5 minutes for each section.

Score: Number correct.

These three tests were developed by the Educational Testing Service; they were not constructed by the author. They were included in the battery to determine their factor structure rather than to be primarily measures of one or another of the four hypothesized factors; however, in the light of the hypotheses it was expected that the Picture section would have its highest loading on Visual Memory, and that the Paragraph and Number sections would be highest on Meaningful Memory.

Table 1 below gives a breakdown of the memory tests by method of testing. The Recognition tests merely require the examinee to recognize stimuli which he has previously experienced; the Completion Recall tests require the examinee to reproduce a part of each previously-examined stimulus when he is presented with the remainder of that stimulus; the Free Recall tests require the examinee to reproduce completely the previously-experienced stimuli.

The next table, Table 2 below, gives a breakdown of the memory tests by type of material and modality of presentation. It will be remembered that this study did not attempt to investigate auditory

TABLE 1. CLASSIFICATION OF THE 27 MEMORY TESTS
BY METHOD OF TESTING RETENTION

Recognition	Completion Recall		Free Recall
	Paired-Associates	Other	
7. Recognition I (Syll.)	3. Memory for Syllables I	1. Memory for Limericks	2. Letter Span I (Vis.)
17. Recognition II (Wds.)	6. Memory for Words I (Unrel.)	4. Consequences I (NVb)	5. Number Span I (Aud.)
20. Map Memory III (Recog.)	18. Memory for Numbers	11. Mean. Memory: Picture	8. Memory for Ideas
23. Recognition III (Figs.)	22. Memory for Syllables II	12. Mean. Memory: Paragraph	9. Map Memory I (Reprod.)
	27. Memory for Words II (Rel.)	13. Mean. Memory: Number	10. Number Span II (Vis.)
		16. Consequences II (Vb)	14. Letter Span II (Aud.)
		19. Map Memory II (Verb.)	15. Reproduction of Visual Designs
		24. Memory for Relations	21. Sentence Span
		25. Sentence Completion	26. Instructions Span

TABLE 2. CLASSIFICATION OF THE 27 MEMORY TESTS BY TYPE
OF MATERIAL AND MODALITY OF PRESENTATION

Type of Material Modality of Presentation	Verbal		Non-verbal	
	Visual	Auditory	Visual	Auditory
	1. Memory for Limericks	5. Number Span I (Auditory)	4. Consequences I (Non-verbal)	(None)
	2. Letter Span I (Visual)	6. Memory for Words I (Unrelated)	11. Meaningful Memory: Picture	
	3. Memory for Syllables I	8. Memory for Ideas	15. Reproduction of Visual Designs	
	7. Recognition I (Syllables)	14. Letter Span II (Auditory)	23. Recognition III (Figures)	
	10. Number Span II (Visual)	16. Consequences II (Verbal)	24. Memory for Relations	
	12. Meaningful Memory: Paragraph	17. Recognition II (Words)		
	13. Meaningful Memory: Number	21. Sentence Span		
	18. Memory for Numbers	26. Memory for Instructions		
	22. Memory for Syllables II			
	25. Sentence Completion			
	27. Memory for Word II (Related)			
	*9. Map Memory I (Reproduction)		*9. Map Memory I (Reproduction)	
	19. Map Memory II (Verbal)		19. Map Memory II (Verbal)	
	20. Map Memory III (Recognition)		20. Map Memory III (Recognition)	

*Although these Map Memory tests were primarily non-verbal, the maps did contain some verbal material, especially Map Memory I.

memory; however, some auditory tests were included in the study in order to estimate the generality of the hypothesized factors of Rote, Meaningful, and Span Memory.

F. Reference Tests

It seems quite evident that the tests described above measure other than just memory abilities. In order to find out what additional abilitieu are being measured, so that these sources of variance can be recognized and allowed for in the interpretation of the memory factors, thirteen additional tests were added to the test battery. Henceforth, these tests will be referred to as reference tests. All of these tests were chosen from the U. S. Air Force Airman Classification Battery; detailed descriptions may be found in the U. S. Army Air Forces Aviation Psychology Program Research Reports (17, 27, 50). Brief descriptions of these tests will be given below. Scores on these tests are reported by the Air Force in terms of stanines; stanines are single-digit scores derived from the raw scores and converted by the Air Force so that a defined population will have a mean score of 5 and a standard deviation of 2. Since all of the examinees had previously taken these tests, it was unnecessary to readminister them along with the memory tests.

28. Instrument Comprehension. CI 616 C-C2.

Type of task: The examinee is presented with drawings of two instruments, a compass and an artificial horizon, followed by five photographs showing an airplane in different positions; he must choose the picture which is in agreement with the two instrument readings.

Number of items: 60.

Time: 15 minutes. This test is fairly highly speeded.

Score: R - W/4.

Factor content: Spatial Relations, Visualization, Reasoning II.

29. Mechanical Principles. CI 903 B.

Type of task: The examinee must answer questions concerning mechanical principles and devices which are illustrated by means of pictures and diagrams.

Number of items: 40.

Time: 20 minutes. This test is not stated to be speeded.

Score: R - W/2 + 20.

Factor content: Deduction, Mechanical Experience, Visualization, Spatial Relations.

30. Rudder Control. CM 120 C.

Type of task: This test requires the manipulation of rudder pedals to bring a cockpit into a condition of equilibrium. The examinee is placed in a model cockpit and instructed to keep a sighting bar on the fuselage in front of him pointed at a target.

Number of trials: 6.

Time: 1 minute per trial.

Score: Total time cockpit is pointed directly at target.

Factor content: Psychomotor Coordination, Visualization, Pilot or Flying Interest.

31. Complex Coordination. CM 701 E.

Type of task: The examinee must respond to complex perceptual signals by making coordinated movements of airplane controls. A

pattern of three red lights in presented to the examinee, who must then manipulate the stick and rudder controls so as to light corresponding green lights; as soon as all lights are matched, a new stimulus pattern is presented.

Number of items: Varies with examinee.

Time: 8 minutes.

Score: Number of patterns correctly matched.

Factor content: Psychomotor Coordination, Spatial Relations.

32. Arithmetic Reasoning. CI 206 C.

Type of task: The examinee must solve mathematical problems which are stated verbally; many of the problems are couched in aviation terms.

Number of items: 30.

Time: 35 minutes. This test is not stated to be speeded.

Score: 2R - W/2.

Factor content: Numerical Facility, Deduction, Verbal Comprehension.

33. Reading Comprehension. CI 614 H.

Type of task: The examinee must make valid inferences from reading material as well as answer more direct questions about content. The paragraphs were taken from technical material, including tests on navigation, physics, map reading, astronomy, and airplane instruments.

Number of items: 8 paragraphs, 36 questions.

Time: 30 minutes. This test is fairly highly speeded.

Score: 2R - W/2.

Factor content: Verbal Comprehension, Deduction, Numerical Facility.

34. **Vocabulary. CI 604 B.**

Type of task: The examinee must select synonyms for given words.

Number of items: 150.

Time: 15 minutes. This test is highly speeded.

Score: R - W/4.

Factor content: Verbal Comprehension.

35. **Dial and Table Reading. CP 622-21 A.**

Type of task: In the dial reading section, the examinee is presented with seven dials such as might be found on the control panel of an airplane; he must answer questions concerning the readings on the dials. In the table reading section he must answer questions which require the consultation of tables of figures.

Number of items: Dial reading section, 57 questions on 10 sets of dials; table reading section, 86 questions.

Time: Dial reading section, 9 minutes; table reading section, 15 minutes. This test is fairly highly speeded.

Score: 1/2(R - W).

Factor content: Perceptual Speed, Numerical Facility, Spatial Relations.

36. **Spatial Orientation I. CP 501 B.**

Type of task: At the top of each test page there is a large aerial photograph, with six circular photographs below it which are sections of it. The examinee must find the area in the large photograph that is the same as each of the small photographs.

Number of items: 49 items based on 9 large aerial photographs.

Time: 5 minutes. This test is highly speeded.

Score: R - W + 20.

Factor content: Perceptual Speed.

37. Coordinate Reading. CP 224 B.

Type of task: The examinee is presented with a circular graph which simulates an oscilloscope screen; this graph is graduated in degrees from 0° to 360°, and in concentric circles representing ten-mile intervals. Located within the circle are dashes representing target returns on the oscilloscope screen. The examinee must determine the bearing and range of each dash line from the center of the circle; the items are multiple-choice in form.

Number of items: 85.

Time: 20 minutes. This test is speeded.

Score: Total number correct.

Factor content: Perceptual Speed, Numerical Facility, Spatial Relations.

38. Discrimination Reaction Time. CP 611 D.

Type of task: The examinee is presented with a visual stimulus pattern, consisting of one red and one green light, in which the principal element is the spatial relation of the two lights. He must make a differential response to this spatial arrangement by tripping one of four switches, the correct switch depending on the position of the red light with respect to the green one.

Number of items: 80 reactions, in 4 groups of 20 each.

Time: Varies with examinee.

Score: Total accumulated time between stimulus and correct response.

Factor content: Spatial Relations, Perceptual Speed, Finger Dexterity.

39. Spatial Orientation II. CP 503 B.

Type of task: Each test page contains a standard aviation map which is sectioned off into twelve squares; below the map are four aerial photographs of portions of the area portrayed in the map. The examinee must match the photographs to the proper sections of the map.

Number of items: 50 items based on 13 aerial maps.

Time: 18 minutes. This test is highly speeded.

Score: $R - W + 20$.

Factor content: Perceptual Speed, Visualization.

40. Numerical Operations. CI 702 B.

Type of task: The examinee must solve simple problems in addition, subtraction, multiplication, and division.

Number of items: Part I (addition and multiplication), 100 items; Part II (subtraction and division), 80 items.

Time: 5 minutes for each part. This test is highly speeded.

Score: $1/2(R - 3W)$.

Factor content: Numerical Facility.

These, then, were the 40 tests making up the test battery. The methods used in the collection and analysis of data will be discussed in the next chapter.

Chapter III

DATA COLLECTION AND ANALYSIS

A. The Population

The population used in this study was composed of U. S. Air Force pilot cadets who were entering basic pilot training at Lackland Air Force Base, San Antonio, Texas, in November, 1952. The total number of cadets taking the 27 memory tests was 480; the testing was done in groups as indicated in Table 3 below.

TABLE 3.   TESTING SCHEDULE

Group	Date	Number tested
1	November 10, 1952 (Monday)	81
2	November 12, 1952 (Wednesday)	78
3	November 13, 1952 (Thursday)	77
4	November 14, 1952 (Friday)	83
5	November 17, 1952 (Monday)	76
6	November 18, 1952 (Tuesday)	85
	Total	480

All of these men had previously taken the tests composing the Air Force Classification Battery, so it was unnecessary to readminister the reference tests. However, reference-test scores were unavailable for some of the men; total data was obtainable for 442, so only these cases were used in this study.

The ages of the examinees ranged from 19 to 27 years, with a mean age of 21.6 years; the complete age distribution is given in Table 4 below.

TABLE 4. AGE OF EXAMINEES

Age in years	Frequency
19	21
20	88
21	114
22	118
23	62
24	21
25	10
26	5
27	3
Total	442
Mean age	21.6

These men had all had at least a high school education; a complete breakdown on amount of education is given in Table 5 below.

TABLE 5. AMOUNT OF EDUCATION OF EXAMINEES

Education	Frequency
11 years	2
12 years	101
1 year college	60
2 years college	142
3 years college	52
4 years college	81
Professional school graduate	4
Total	442

B. The Testing Procedure

All testing was conducted by a regular testing team from the Human Resources Research Center; the author was present at all testing sessions as an observer and adviser. Since the tests were administered by Air Force personnel, and since many Air Force tests were taken during the same sessions as the memory tests, there is reason to believe that the men considered the memory tests as a regular part of

the Air Force testing. It was hoped that the regular orientation state-
ment made by the testing officer at the outset of the testing would
provide sufficient motivation for the subjects to perform as well as
possible.

Each examinee was completely tested in a single day; there were
two testing sessions, morning and afternoon. In the morning session,
three Air Force tests were administered; following this, the men were
given a ten-minute break during which they were allowed to leave the
room. After the break they were given another Air Force test, and then
Book I of the memory battery was administered. After Book I, there
was a 2-3 minute break during the collection of Book I and the distri-
bution of Book II. After the administration of Book II, the men were
dismissed for lunch. In the afternoon session, the first test admin-
istered was another Air Force test; then Book III of the memory battery
was given. The men were allowed to take a ten-minute break between
tests 22 and 23. The last test for the day was an Air Force test.
All of these Air Force tests were unrelated to this study.

In addition to these tests, each man spent another full day taking
only Air Force tests; groups 2, 4, and 6 took these tests before taking
the memory battery, while groups 1, 3, and 5 took these tests after
taking the memory tests.

C. Scoring of Tests

All 27 of the memory tests were independently scored twice; any
discrepancy in score was eliminated by a third scoring of that test.
Two of the tests, 15, Reproduction of Visual Designs, and 8, Memory
for Ideas, were scored by the author; the other tests were all scored

by members of the scoring staff at the Educational Testing Service.
The actual scoring methods used were reported in Chapter II.

The single-digit stanine scores on the reference test were
furnished by the Air Force.

The frequency distribution of test scores, the mean, and the
standard deviation of each test are presented in Appendix B. Table
C-1 (Appendix C, first table) gives the total possible score, the mean,
and the standard deviation for all 40 tests in the battery.

No direct measurement of the reliability of the 27 memory tests
was made; however, two types of indirect estimates are available. It
can be shown that the reliability of a test is equal to or greater
than the correlation between that test and any other variable; also,
the final computed communality estimate, h_j^2, for each test j furnishes
another lower-bound estimate of the reliability coefficient, since
$h_j^2 \leq r_{jj}$ (61, p. 84). The intercorrelation coefficients of the tests
are presented in Table C-2; the final communality estimates are shown
in Table C-11. For the purposes of a factor analysis study it is not
necessary that a test be as reliable as it should be if it were to be
used for the selection of individual examinees; with this in mind it
can be seen that most of the tests in the battery are reliable enough
to yield meaningful factorial results.

Reliability data on the 13 reference tests have been reported by
the Air Force (17, 27, 50).

D. Computation of Correlation Coefficients

The correlation coefficients were computed entirely on I.B.M.
equipment. The scores on the 40 tests were punched into I.B.M. cards;

then sums, sums of squares, and sums of cross-products were tabulated and automatically punched in summary cards. These tabulations were made at the Educational Testing Service using a type 402 Accounting Machine, together with appropriate auxiliary equipment. (A type 405 Accounting Machine could have been used just as well.)

The coefficients of correlation were then computed on an I.B.M. Card-Programmed Calculator by the Computation Laboratory at the Forrestal Research Center of Princeton University. These computations were made from the data on the summary cards prepared at the Educational Testing Service.

Table C-2 presents the intercorrelations of the 40 tests.

E. Factor Analysis of the Complete Battery

The multiple group method of factoring (61, pp. 170-175) was used to obtain the original unrotated orthogonal factor matrix. Expressed in matrix algebra, the method given by Thurstone is as follows:

R_{jk} = reduced correlation matrix (communality estimates in diagonal cells).

W = weight matrix defining groups.

$$R_{jk}W = Z \quad . \tag{1}$$

$$Z'W = W'R_{jk}W = T \quad . \tag{2}$$

$$Y \equiv \text{a diagonal matrix with entries equal to } 1/\sqrt{t_{ii}} \quad . \tag{3}$$

$$YTY = R_{pq} \text{ (i.e., } Y \text{ is so defined that } R_{pq} \text{ has unit diagonals).} \tag{4}$$

$$R_{pq} = E'E \quad . \quad R_{pq} \text{ is factored by the diagonal or tri- angularization method. (61, pp. 101-105.)} \tag{5}$$

E^{-1} is computed.

$$ZY = U \quad . \tag{6}$$

$$UE^{-1} = F \quad , \text{ where } R_{jk} = FF' \quad . \tag{7}$$

Dr. Ledyard R Tucker suggested shortening the computations by eliminating the steps involving the Y matrix as being unessential, so the method reduced to the following steps:

$$R_{jk}W = Z \quad . \tag{8}$$

$$Z'W = W'R_{jk}W = T \quad . \tag{9}$$

$$T = B'B \quad . \quad T \text{ is factored by the diagonal method.} \tag{10}$$

$$B^{-1} \text{ is computed.}$$

$$ZB^{-1} = F \quad , \text{ where } R_{jk} = FF' \quad . \tag{11}$$

In the equations given above, the matrix W defines the groups; the groups were chosen as representing clusters in the correlation matrix. A first examination of the matrix of intercorrelations resulted in the selection of seven groups; the intercorrelation matrix R_o is given in Table C-2, and the matrix W_a defining the first seven groups is given in Table C-3. The highest correlation coefficient in each column of the correlation matrix was chosen as the first communality estimate for that variable, and these seven groups were factored out of the correlation matrix by the method outlined above; this resulted in a factor matrix F_a, given in Table C-4.

A matrix of residual correlation coefficients, R_a, was then computed by the formula:

$$R_a = R_o - F_a F_a' \quad . \tag{12}$$

Matrix R_a is given in Table C-5. An examination of R_a revealed four groups or clusters; matrix W_b, Table C-6, defines these groups. The communalities were reestimated in the same manner as before, and then these four groups were factored out of R_a, giving factor matrix F_b, Table C-7.

Again the residual correlations were computed, and an examination of this matrix R_b, Table C-8, failed to reveal any additional groups. Since no further groups were indicated, and since the residual correlations were so small, no further factors were extracted; thus matrix R_b is the first matrix of residual correlation coefficients, henceforth referred to as matrix R_1. Matrices F_a and F_b were combined into a single factor matrix F_1, which is shown in Table C-9.

All of these computations were carried out on the Card-Programmed Calculator at the Forrestal Research Center of Princeton University. Since high-speed computing was available, it was decided to iterate the factor solution to stabilize both the communalities and the weights defining the groups. Accordingly, the communality estimates computed from factor matrix F_1 were inserted in the diagonal cells of R_o, and the matrix F_1 was used as the new weight matrix to define the groups. A new factor matrix F_2 was extracted by the method previously outlined, and the communality estimates from F_2 were computed. Matrix F_2 and the corresponding new communality estimates computed from it are shown in Table C-10.

The iteration of the solution to stabilize the communality estimates is a standard recommended procedure (61, p. 295). This type of iteration of the factor weights is simply Hotelling's iterative method of factoring (61, p. 483); this method if carried to complete convergence will yield the principal-axis factor matrix.

It was decided to iterate the solution yet another time, hence the communality estimates computed from F_2 were inserted in the diagonal cells of R_o and F_2 was used as the weight matrix to define the groups. However, a difficulty was encountered in the process of extracting the factors. It will be noticed that equation (10) calls for the factoring of a small matrix T into a matrix B and its transpose B'; the diagonal or triangularization method of factoring was used (61, pp. 101-105). In carrying out the triangularization, the lower right-hand entry in B, the last value to be computed, turned out to be an imaginary number.

This difficulty might arise from either of two causes: (1) The true rank of the reduced matrix R_o might be ten rather than eleven. Since the solution is converging to the principal axis solution the amount of variance on the eleventh factor is in a sense being minimized; hence, if the eleventh factor is actually only some sort of random "noise" factor, this might show up as a negative root of the characteristic equation which could cause the imaginary number found in this analysis.

(2) On the other hand, it is possible that such an imaginary number could arise if most or all of the communality estimates were too low. It seems quite likely that this method of iterating the communality estimates might bring about this situation. Consider this problem in the following manner. Let the correlation matrix, with unities in the diagonals, be factored; the complete factor matrix may be considered to be composed of three subsections—a common factor section, a "noise" or residual factor section, and a "unique" factor section. The iteration of communality estimates in the manner described above will result in a convergence only to the values based on the common factor section;

but the correlation matrix, even when reduced by subtracting out the unique factor section, still contains the "noise" factors, which are small to the point of being negligible but are nevertheless present. Thus it would occur that the communality estimates obtained would be underestimates of the values which actually should have been used.

Since the appearance of the imaginary number meant that if the analysis was continued the loadings on the eleventh factor would all be imaginary numbers, some action was felt to be desirable. It was decided to add .05 to each communality estimate computed from F_2 and to recompute the second iteration. If the rank of the reduced correlation matrix were truly ten instead of eleven, this fact would become apparent when the factor matrix was rotated; if the second situation outlined above prevailed, this addition of .05 should probably be enough to correct the difficulty.

After this .05 was added to the communality estimates, the solution was iterated with no further difficulty to obtain F_3, which is shown in Table C-11; again new communality estimates were computed. Table 6 below shows the summary statistics for the frequency distributions of the differences between each set of communality estimates.

TABLE 6. DISTRIBUTION STATISTICS FOR THE
DIFFERENCES BETWEEN SUCCEEDING COMMUNALITY ESTIMATES

	$h_1^2 - h_0^2$	$h_2^2 - h_1^2$	$h_3^2 - h_2^2$
Range	-.37 to +.25	-.02 to +.10	-.09 to +.04
Mean	.026	.051	-.030
S.D.	.123	.024	.025

h_0^2 = Original communality estimates

h_1^2 = Communality estimates used in first iteration

h_2^2 =   "   "   "   " second iteration

h_3^2 =   "   "   computed from factor matrix F_3

A new matrix of residual correlations was computed; an examination of the matrix R_3 (Table C-12) failed to reveal any additional groups. The distribution of these residual correlation coefficients is summarized in Table 7 below.

TABLE 7. DISTRIBUTION STATISTICS FOR THE RESIDUAL
CORRELATION COEFFICIENTS IN MATRIX R_3

Range   -.0890 to .0979

Mean   -.0005

S.D.   .0300

Since the factor matrix was to be rotated to a psychologically meaningful position, it was not necessary to continue to iterate until complete convergence to the principal axis solution was obtained. It was felt that the solution was near enough to the principal space at this time, so no further iterations were performed; thus matrix F_3 (Table C-11) is the final unrotated orthogonal factor matrix.

F. Independent Analysis of Reference Tests

In order to clarify the identification of the reference factors, it was decided to factor-analyze independently just the intercorrelations of the 13 reference tests. A centroid analysis was performed; all computations were done on a desk calculator. Five factors were extracted; these factors were rotated to oblique simple structure. All pertinent data are presented in Appendix D.

G. Rotation of Axes

The rotation of axes was greatly facilitated by the use of the Matrix Rotator at The Adjutant General's Office in Washington, D. C. First, the axes were rotated orthogonally until a fairly good simple structure was obtained; then the axes were rotated obliquely to improve the simple structure. After the author's return to Princeton, nine additional rotations were made in order to clarify further the simple structure. The rotated oblique factor matrix, V, is presented in Table C-14; the correlations between the primary factors are shown in Table C-16.

Throughout the report the entries in the V matrix will be referred to as "factor coefficients" rather than as "factor loadings." In the oblique case, a factor loading is generally considered to be the oblique projection of a test vector on a primary-factor vector; an entry in the V matrix, however, represents the orthogonal projection of a test vector on a reference-factor vector.

The exact relationships between all the variables in the oblique case have been shown ($\underline{61}$, pp. 347-359); among other relations it was shown that the factor coefficients are proportional to the factor loadings. Some of these relationships may be expressed in the following manner:

Let R_{jk} = reduced correlation matrix.

F_{jm} = unrotated orthogonal factor matrix.

A_{mo} = oblique transformation (rotation) matrix.

V_{jo} = rotated oblique matrix of factor coefficients.

D_{po} = orthogonal projections of primary-factor vectors on reference-factor vectors. (This is a diagonal matrix; all off-diagonal cell entries are zero.)

$$A_{jp} = \text{rotated oblique matrix of factor loadings.}$$

Then

$$R_{jk} = F_{jm}F_{jm}' \qquad . \tag{13}$$

$$F_{jm}A_{mo} = V_{jo} \qquad . \tag{14}$$

$$V_{jo}D_{po}^{-1} = A_{jp} \qquad . \tag{15}$$

$$R_{jk} = V_{jo}(A_{mo}'A_{mo})^{-1}V_{jo}' \qquad . \tag{16}$$

$$R_{jk} = A_{jp}R_{pq}A_{jp}' \quad , \text{ where } R_{pq} = D_{po}(A_{mo}'A_{mo})^{-1}D_{po} \quad . \tag{17}$$

The V matrix of factor coefficients is the matrix usually reported
in factor analysis studies using oblique rotations; quite commonly,
however, the entries in this matrix are referred to as factor loadings.
The term "factor coefficient" has been adopted in order to indicate
precisely that the V matrix, not the A matrix, is being reported.

In interpreting the factors, either matrix (coefficients or load-
ings) will place the tests in the same rank-order of magnitude; in
general, the magnitude of the factor coefficients seem to the author
to be more useful in making the interpretation. Since in most other
obliquely-rotated analyses the V matrix has been reported instead of
the A matrix, it seems logical to assume that other authors have also
found it preferable.   ·

The interpretation of the factors will be presented in the fol-
lowing chapter.

Chapter IV

RESULTS AND INTERPRETATION

A. Factor Analysis of Reference Tests

This section will be devoted to the discussion of the results of the factor analysis of intercorrelations of the reference tests; section B of this chapter will consider the results of the analysis of the intercorrelations of the complete battery of tests. Table D-5 presents the rotated oblique factor matrix, V, for the analysis of the 13 reference tests. The five factors which were extracted are identified below; the information in Tables 8-12 was taken from Table D-5.

TABLE 8. TESTS HIGH ON REFERENCE-TEST FACTOR A

Test	Factor Coefficient
31. Complex Coordination	.58
30. Rudder Control	.49
29. Mechanical Principles	.37
28. Instrument Comprehension	.22
38. Discrimination Reaction Time	.20

Reference-Test Factor A: Kinesthetic-Spatial Relations. This factor appears to represent the ability to coordinate and integrate a visual-spatial stimulus with kinesthetic senations. (These sensations may be real or they may result from kinesthetic imagery.) This factor apparently represents a confounding of the Psychomotor Coordination and the Space factors identified by French (21).

47

TABLE 9.   TESTS HIGH ON REFERENCE-TEST FACTOR B

Test	Factor Coefficient
34. Vocabulary	.66
33. Reading Comprehension	.59

Reference-Test Factor B: Verbal Comprehension. Although this factor
is only a doublet, it is such a well-established factor that it may
be interpreted as representing knowledge of language and facility in
the manipulation of verbal material.

TABLE 10.   TESTS HIGH ON REFERENCE-TEST FACTOR C

Test	Factor Coefficient
32. Arithmetic Reasoning	.54
29. Mechanical Principles	.45
37. Coordinate Reading	.33
39. Spatial Orientation II	.31
28. Instrument Comprehension	.27
33. Reading Comprehension	.26

Reference-Test Factor C: Deduction-Visualisation. This factor ap-
pears to represent the ability to reason from the general to the
specific in situations requiring the manipulation of objects in the
imagination. There seems to be confounding of the Visualization
factor with the Deduction factor; these factors were both defined by
French (21).

TABLE 11.   TESTS HIGH ON REFERENCE-TEST FACTOR D

Test	Factor Coefficient
40. Numerical Operations	.62
32. Arithmetic Reasoning	.48
35. Dial and Table Reading	.48
37. Coordinate Reading	.33

Reference-Test Factor D: Numerical Facility. It seems clear that this factor represents facility in the manipulation of numbers.

TABLE 12. TESTS HIGH ON REFERENCE-TEST FACTOR E

Test	Factor Coefficient
36. Spatial Orientation I	.53
37. Coordinate Reading	.52
39. Spatial Orientation II	.49
28. Instrument Comprehension	.35
35. Dial and Table Reading	.35

Reference-Test Factor E: Perceptual Speed. This factor appears to represent the ability to inspect and compare visual forms rapidly.

The intercorrelations of these primary factors are shown in Table D-6. It can be seen that Reference-Test Factors A, B, D, and E intercorrelate positively to a moderate degree, while Reference-Test Factor C is more independent of the others. Within a population as highly selected as this one it is to be expected that the factors will show moderate intercorrelations such as these.

These results show that this group of reference tests clearly identifies three factors, while two other factors which involve visual tasks are not very clear. Thus this set of reference tests is not as good as was desired for this study, since one of the four factors hypothesized was the Visual Memory factor. However, it is possible that the inclusion of the tests specifically designed to measure Visual Memory might help to clarify the factor structure in this area; Visual Memory is again discussed along with Factors I, J, and K in the next section of this chapter.

B. Factor Analysis of the Complete Battery

The results of the analysis of the complete battery of 40 tests, together with the interpretation of these results, are given below. Table C-14 presents the rotated oblique factor matrix, V, for the analysis of the complete battery. The eleven factors which were extracted are identified in the following pages; the information in Tables 13-23 was taken from Table C-14.

TABLE 13. TESTS HIGH ON FACTOR A

Test	Factor Coefficient
*34. Vocabulary	.60
*12. Meaningful Memory: Paragraph	.51
*33. Reading Comprehension	.48
*21. Sentence Span	.38
32. Arithmetic Reasoning	.25

*This test had its highest factor coefficient on this factor.

Factor A: Verbal Comprehension. This factor appears to represent knowledge of language and facility in the manipulation of verbal material; it corresponds to Reference-Test Factor B and to Factor V as identified by French (21, p. 244). The interpretation of this factor seems to be very clear.

TABLE 14. TESTS HIGH ON FACTOR B

Test	Factor Coefficient
*40. Numerical Operations	.67
*32. Arithmetic Reasoning	.54
35. Dial and Table Reading	.47
37. Coordinate Reading	.35
24. Memory for Relations	.26

*This test had its highest factor coefficient on this factor.

Factor B: Numerical Facility. This factor seems to represent facility in the manipulation of numbers; it corresponds to Reference-Test Factor D and to Factor N as identified by French (21, p. 225). Again there does not seem to be much question as to the interpretation of this factor.

One might ask about the two number span tests, tests 5 and 10, and about the paired associates word-number test, test 18. The two number span tests have factor coefficients in the indeterminate range where it is not at all clear whether or not to consider the coefficients as being significantly different from zero; the coefficient of the word-number test is clearly not significantly different from zero. The magnitudes of these coefficients fit in with the interpretation of this factor made above, i.e., the mere presence of numbers in a test is not sufficient for that test to have a high coefficient on this factor; rather, the tests with high coefficients on this factor all seem to require the manipulation of numbers in some manner.

TABLE 15. TESTS HIGH ON FACTOR C

Test	Factor Coefficient
*36. Spatial Orientation I	.70
*35. Dial and Table Reading	.58
*37. Coordinate Reading	.52
39. Spatial Orientation II	.43
*38. Discrimination Reaction Time	.39
* 9. Map Memory I (Reproduction)	.35
31. Complex Coordination	.31
28. Instrument Comprehension	.28
40. Numerical Operations	.26
* 4. Consequences I (Non-verbal)	.23
15. Reproduction of Visual Designs	.22
24. Memory for Relations	.22
20. Map Memory III (Recognition)	.21

*This test had its highest factor coefficient on this factor.

Factor C: Perceptual Speed. This factor appears to represent the ability to perceive rapidly; tests with high coefficients on this factor involve the rapid inspection and comparison of visual forms, with the notation of similarities and differences in form and detail. This factor corresponds to Reference-Test Factor E and to Factor P as identified by French (21, p. 277). The identification of this factor also is quite clear.

TABLE 16. TESTS HIGH ON FACTOR D

Test	Factor Coefficient
* 6. Memory for Words I (Unrelated)	.64
*17. Recognition II (Words)	.53
*18. Memory for Numbers	.53
3. Memory for Syllables I	.41
*13. Meaningful Memory: Number	.36
27. Memory for Words II (Related)	.36
22. Memory for Syllables II	.34
14. Letter Span II (Auditory)	.33
5. Number Span I (Auditory)	.27
10. Number Span II (Visual)	.26
7. Recognition I (Syllables)	.21
2. Letter Span I (Visual)	.20
12. Meaningful Memory: Paragraph	.20

*This test had its highest factor coefficient on this factor.

Factor D: Rote Memory. There seems to be little doubt that this is a memory factor; it is interpreted as representing the ability to remember bits of unrelated factual material. This factor corresponds to Factor M identified by French (21, p. 219).

Tests 3, 6, 7, 17, 18, and 22 were constructed in an attempt to measure the hypothesized factor of Rote Memory; all of these tests have high coefficients on this Factor D. In addition, tests 6, 17, and 18 have their highest coefficients on this factor, while tests 3 and

22 have higher coefficients only on a doublet factor which represents the common variance of these two paired-associates nonsense-syllable tests. Test 7, while being low on this factor, is low on all factors; its highest coefficient is only .24, on Factor I. The communality of this test is only .32; hence either the test is very unreliable or else it has a great amount of specific variance.

Now, what is the nature of tests 2, 5, 10, 12, 13, 14, and 27, the tests with moderately high coefficients on this factor which were designed to be primarily measures of other factors? Tests 2, 5, 10, and 14 are the number span and letter span tests; it does not seem unreasonable for these tests to have high coefficients on a rote memory factor. However, the coefficients for these four tests are comparatively low, and they all have higher coefficients on Factor F; more will be said about them when Factor F is discussed. Tests 12 and 13 were two of the three experimental tests not specifically constructed for this study, but it was thought that they would be primarily measures of a meaningful memory factor; more will be said about these two tests in the discussion of Factor E below. Test 27 will also be discussed with Factor E. However, in examining the nature of each of these tests, it does not seem particularly surprising that they should appear on a rote memory factor as defined above.

Most of the tests with high coefficients on this factor are composed of relatively discrete elements; in general, no obvious relationships exist among the elements. There are a few tests where some relationships do exist, tests 27, 12, and 13. (Test 27 had a higher coefficient or Factor E, to be discussed next.) It seems not unlikely that on these three tests some examinees did not make use of the relation-

ships in remembering the elements, which would account for the appear-
ance of these tests on this Rote Memory factor. This possibility could
be checked by getting introspective reports from examinees.

What conclusions can be drawn about this factor? First, the Rote
Memory factor did not split into two separate factors—recognition and
paired associates. The memory tests in this battery may be roughly
classified into three categories: Recognition, Completion Recall (in-
cluding paired associates and multiple choice), and Free Recall. It
may be seen in Table 16 that tests from all three of the categories
appear on this factor; it is true that the five paired associates tests
are among the top seven tests, while one of the other two tests in this
top group is also a completion recall test. However, test 17, with the
second highest coefficient on this factor is a recognition test; and
the number span and letter span tests, with lower coefficients, are
free recall tests. Thus on the basis of this study it may be concluded
that completion recall tests, in particular paired associates tests,
are the best measures of this factor, but that the factor is not
restricted to tests of this kind.

It can be seen that the content of the tests with high coeffi-
cients on the Rote Memory factor includes numbers, letters, nonsense
syllables, and words. This factor is not specific to one modality of
presentation, since some of the tests were presented visually and some
were presented auditorily. However, all of this material is verbal,
and the testing necessitates verbalization of the material by the
examinee; hence it is quite possible that this factor is restricted to
verbal material. This is a problem which must be investiged
further.

TABLE 17. TEST HIGH ON FACTOR E

Test	Factor Coefficient
*25. Sentence Completion	.53
* 1. Memory for Limericks	.48
*16. Consequences II (Verbal)	.44
*27. Memory for Words II (Related)	.43
8. Memory for Ideas	.35
*11. Meaningful Memory: Picture	.22
23. Recognition III (Figures)	.21

*This test had its highest factor coefficient on this factor.

Factor E: Meaningful Memory. This factor seems to represent the ability to remember material which is meaningful. The term "meaningful" has not been precisely defined; only an intuitive definition of its meaning has been implied, both in the test construction and in the identification made above.

Tests 1, 4, 8, 16, 24, 25, and 27 were specifically constructed in an attempt to measure the hypothesized factor of "Meaningful Memory," while tests 12 and 13 were also thought to be measures of such an ability. It will be noted that five of these seven tests (numbers 4 and 24 are the exceptions) are high on this factor; of these five, only test 8 does not have its highest coefficient here.

Several specific tests need to be considered; for example, what happened to tests 4 and 24? Test 4, Consequences I (Non-verbal), turned out to be much too easy for this population; the score distribution was extremely negatively skewed, with the large majority of examinees making perfect or near-perfect scores; its coefficient on this factor was in the indeterminate range of possible significance.

Test 24, Memory for Relations, had essentially a zero coefficient on this factor; although this test seems to line up more with the visual tests than with those on this factor, its nature is not made clear in the analysis of this test battery. The coefficients on Factors I and K perhaps indicate that the examinees were not making use of the relations in remembering the matrices; the relations themselves may have been too difficult to be discovered in the time allowed for this test. If this were true, it would not be surprising to find that those examinees who are high on a visual memory ability make the better scores on this test.

Tests 12 and 13 did not appear on this factor either; test 12 seems to be primarily a measure of verbal comprehension, with a slight component of Rote Memory, while test 13 seems to be fairly complex, with a moderate coefficient on the Rote Memory factor. If this factor is indeed Meaningful Memory, then it might be suggested that either there is not enough "meaning" in tests 12 and 13 for them to appear on this factor, or else that the type of "meaning" they contain is not that which distinguishes this factor. In addition, test 13 was too easy for this group, thus giving a very skewed score distribution.

Tests 11 and 23 appear on this factor with comparatively low coefficients. In test 11, Meaningful Memory: Picture, there is, at least in some sense, meaning; however, this coefficient of .22 is the highest coefficient that this test has on any factor, so perhaps the best that can be said is that the nature of this test is not clarified by this battery. An examination of the nature of test 23, Recognition III (Figures), shows that a number of the figures seem to be representations of objects; perhaps this might explain its

coefficient on this factor; however, this test also has no very high coefficients, so its nature remains questionable.

The following conclusions with regard to Factor E may now be stated. The modality of presentation of the test material is not a discriminatory characteristic for this factor; both visually-presented and auditorily-presented tests have high coefficients.

All three types of tests--recognition, completion recall, and free recall--appear on this factor. Although the free recall and recognition tests have low coefficients, it seems justified to conclude on the basis of these results that this factor is not restricted to completion recall tests.

With regard to the content of the tests the evidence is somewhat uncertain. The tests with the highest coefficients are all composed of verbal material (words and sentences), but the tests with lower coefficients involve non-verbal material (pictures and geometrical figures). It is unfortunate that test 4, Consequences (Non-verbal), turned out to be too easy, since it was intended to clarify this very point, i.e., whether or not this factor is limited to verbal material. It is necessary to conclude that this question is not completely settled by this study; however, the results seem to indicate that this factor is not limited to verbal material.

Taking all this information, along with the nature of the tests which have essentially zero coefficients on this factor, into consideration, some sort of element of meaning seems to be the characteristic which distinguishes between those tests which have high coefficients and those which have low coefficients.

TABLE 18.   TESTS HIGH ON FACTOR F

	Test	Factor Coefficient
* 2.	Letter Span I (Visual)	.66
*14.	Letter Span II (Auditory)	.61
*10.	Number Span II (Visual)	.59
* 5.	Number Span I (Auditory)	.57
*26.	Memory for Instructions	.41
21.	Sentence Span	.24
22.	Memory for Syllables II	.20

*This test had its highest factor coefficient on
this factor.

Factor F: Span Memory. As hypothesized, this factor seems to
represent the ability to recall perfectly for immediate reproduction
a series of unrelated items after only one presentation of the series.

Tests 2, 5, 10, 14, 21, and 26 were constructed in an attempt to
measure Span Memory; it can be seen that all of these tests are present
on this factor, and all but one of them has its highest coefficient on
this factor. Test 21, Sentence Span, has its highest coefficient on
the Verbal factor, a not unreasonable result. The only other test in
the battery which appears on this Span Memory factor is test 22,
Memory for Syllables II. Tests 3 and 22, which were designed to be
parallel tests, were both too difficult for this population, and from
the factorial results it seems logical to assume that the examinees
changed their method of learning the syllables between the first and
the second tests.

The tests in this study which had high coefficients on this Span
factor were all free recall tests, with the exception of test 22, a
completion recall test, which was discussed above. It is quite prob-
able that the Span factor is restricted to tests of free recall; this
should be investigated further.

With regard to content, these span tests included numbers, letters, words, and sentences, all verbal material. It would be highly desirable to determine whether tests of non-verbal material are also measures of this factor.

This study presents fairly clear evidence that visually-presented and auditorily-presented span tests measure the same factor rather than two different factors as they might have done.

TABLE 19. TESTS HIGH ON FACTOR G

Test	Factor Coefficient
* 1. Memory for Syllables I	.58
*22. Memory for Syllables II	.35

*This test had its highest factor coefficient on this factor.

Factor G: Doublet. This factor quite clearly represents only the specific variance in tests consisting of nonsense syllables presented in the form of paired associates. It cannot be considered to be a group factor for paired associates tests in general, since none of the other tests of this kind have significant coefficients on this factor. Thus it can be concluded that a test of nonsense syllable paired-associates measures something distinct from everything that is measured by all the other tests in the battery, but there is not enough information here to indicate the exact nature of this specific ability or abilities.

TABLE 20.   TESTS HIGH ON FACTOR H

Test	Factor Coefficient
* 8. Memory for Ideas	.54
1. Memory for Limericks	.32
21. Sentence Span	.28

*This test had its highest factor coefficient on this factor.

Factor H: Unidentified Triplet. There are not enough tests with high coefficients on this factor in order for any clear interpretation of its nature to be made. Perhaps the most logical guess is that this may be an Auditory Memory factor, representing the ability to remember material by the formation of an auditory image. Both tests 8 and 21 were presented auditorily; while test 1 was presented visually, the type of material composing this test would lend itself quite well to auditory retention as defined above. Three other tests which were presented auditorily--test 6, Memory for Words I (Unrelated); test 16, Consequences II (Verbal); and test 17, Recognition II (Words)--have coefficients in the indeterminate range of magnitude, but two visually-presented tests--test 4, Consequences I (Non-verbal); and test 29, Mechanical Principles--also have coefficients in this range.

It must be noted, however, that none of the auditorily-presented span tests, with the exception of Sentence Span, appear on this factor, so it is not an auditory-presentation factor. Perhaps it would be more precise to think of it as an Auditory Verbal Memory factor.

This factor is not clearly identifiable with any of the factors reported by Karlin (40, 41).

It is also possible that this triplet represents another kind of meaningful memory factor, although it is not at all clear what the nature of such a factor would be.

TABLE 21.   TESTS HIGH ON FACTOR I

Test	Factor Coefficient
*39. Spatial Orientation II	.48
*20. Map Memory III (Recognition)	.46
29. Mechanical Principles	.44
15. Reproduction of Visual Designs	.43
*24. Memory for Relations	.39
*28. Instrument Comprehension	.32
33. Reading Comprehension	.31
*23. Recognition III (Figures)	.28
32. Arithmetic Reasoning	.28
9. Map Memory I (Reproduction)	.25
*7. Recognition I (Syllables)	.24
37. Coordinate Reading	.24

*This test had its highest factor coefficient on this factor.

Factor I: Visualization?   As will be seen in the consideration of Factors J and K below, this battery of tests was not so chosen as to indicate clearly the structure in the visual-spatial factor domain; Factors I, J, and K seem to represent the variance which has been attributed in previous analyses (21, 27) to the factors Visualization, Space, Deduction, Psychomotor Coordination, and perhaps Visual Memory as well. This confusion most likely is due to the structure of the test battery; unfortunately, it seems that the reference tests did not include enough relatively independent measures of each of the above-mentioned factors to separate them clearly in the analysis. The confounding resulted from the complex interrelations of the reference tests used; this confusion was evidenced in the reference-test analysis discussed earlier in this chapter. For this reason, the iden-

tifications made for the following three factors are all very tentative and not at all clear-cut.

This factor seems most nearly to correspond to the Visualization factor reported by the Air Force (27). This factor has been defined by French (21, p. 247) as the ability to comprehend imaginary movements in three-dimensional space or the ability to manipulate objects in the imagination. Many of the tests with high coefficients on this factor, however, do not involve any such manipulation, so this definition does not seem to be too good for Factor I; therefore, this identification is made only very tentatively. There is some indication that this factor may represent a confounding of Visualization and Visual Memory.

TABLE 22. TESTS HIGH ON FACTOR J

Test	Factor Coefficient
#29. Mechanical Principles	.55
#30. Rudder Control	.52
#31. Complex Coordination	.48
32. Arithmetic Reasoning	.46
28. Instrument Comprehension	.30
33. Reading Comprehension	.28

*This test had its highest factor coefficient on this factor.

Factor J: Kinesthetic-Spatial-Reasoning? This factor seems to represent a confounding of three of the factors defined by French (21)—Psychomotor Coordination, Space, and Deduction. Psychomotor Coordination was interpreted by him as representing the ability either to integrate muscular movements or to coordinate the eye and muscular movements, especially of the hand. The Space factor was interpreted as the ability to perceive spatial patterns accurately and to compare them

with each other; the Space factor may or may not be limited to visual perception. The Deduction factor was identified as the ability to reason from the general to the specific. This identification of Factor J is very tentative.

TABLE 23. TESTS HIGH ON FACTOR K

Test	Factor Coefficient
*15. Reproduction of Visual Designs	.55
13. Meaningful Memory: Number	.31
24. Memory for Relations	.28
32. Arithmetic Reasoning	.28
23. Recognition III (Figures)	.26
6. Memory for Words I (Unrelated)	.25
*19. Map Memory II (Verbal)	.24
5. Number Span I (Auditory)	.21
18. Memory for Numbers	.21

*This test had its highest factor coefficient on this factor.

Factor K: Unidentified. It will be noticed that only one test has a very high coefficient on this factor; the other tests which seem to be on this factor have only low to moderate coefficients. In this situation the position of the hyperplane was not too clearly defined, and there does not seem to be any interpretation which is clear enough to warrant giving this factor any identifying title at all. It seems likely that if the nature of Factors I and J were clarified, this factor might also be clarified; in that case it is possible that this factor might well turn out to represent the hypothesized factor of Visual Memory. From this analysis of the battery as it was constituted, it is not possible to conclude that a Visual Memory factor exists; however, neither is it possible to cite these results as evidence that such a factor does not exist, since on this point the results are too equivocal.

In spite of the equivocality of the results it still seems likely that a Visual Memory factor could be demonstrated in another study. Clearly, there should be more and better tests constructed which are specifically designed to measure such a factor, and the reference tests in the battery need to be very carefully chosen in order to avoid the confusion in factor structure encountered in this study.

The intercorrelations of these primary factors are presented in Table C-16. It can be seen that the intercorrelations of Factors A-H have in general either approximately zero or low positive values. The only correlation coefficient in this group which exceeds .28 is that of .43 between Factor A, Verbal Comprehension, and Factor E, Meaningful Memory. This particular correlation is not surprising since, as has already been pointed out, the tests with the highest factor coefficients on Meaningful Memory were all composed of verbal material; if better non-verbal tests of Meaningful Memory can be developed, it is to be expected that this correlation will decrease. The other correlations seem to be reasonable in terms of the restriction of the population. It may be noted that the Rote and Meaningful Memory factors correlate only .28, while Span Memory fails to correlate with either of these other two memory factors; thus there seems to be no evidence for a general second-order memory factor. Since Factors I, J, and K are so poorly determined, no particular significance can be attached to their correlations either with the other factors or with themselves; however, it may be noted that none of these correlations are especially high.

In summary, it was possible to give clear interpretations for three reference factors, three memory factors, and one doublet factor;

three factors involving visual tasks remain unclear; and the other factor, a triplet, is suggestive but uncertain. The following chapter will summarize the entire study, and recommendations for further research will be made.

Chapter V

SUMMARY AND RECOMMENDATIONS

A. Summary of Study

This study was undertaken to investigate the factorial structure
in that part of the area of memory involving relatively immediate
intentional retention. The development of 24 tests of memory was
guided by the following factors which were hypothesized as covering
important parts of this area of the memory domain:

1. Rote Memory: the ability to recall learned, meaningless
material.

2. Meaningful Memory: the ability to recall learned, meaningful
material.

3. Span Memory: the ability to recall perfectly a series of
unrelated items after only one presentation of the series.

4. Visual Memory: the ability to recall material learned by
the formation of an image of a whole visual field.

Three additional memory tests previously constructed by the Edu-
cational Testing Service were also included in this study.

In order to assess the generality of whatever memory factors might
be found, tests of varied content and type were used. The battery in-
cluded both verbal and non-verbal tests; some tests required recogni-
tion, some depended upon completion recall, while others depended upon
free recall; some tests were presented visually, while others were ad-
ministered auditorily. The material used included numbers, letters,
nonsense syllables, words, sentences, stories, limericks, maps, pictures,

and geometric designs and symbols. A few tests of delayed retention were included, but the longest delay was only about 30 minutes.

Since the factor analysis was operationally independent of the hypotheses, once the test battery was constructed, the analysis reveals the structure underlying the behaviors covered by the test battery; thus the analysis provides a check on the foregoing hypotheses or indicates alternative hypotheses. To clarify the nature of the memory factors, 13 reference tests measuring previously identified aptitude factors were included in the battery, bringing the total number of tests up to 40.

These tests were administered to 442 pilot cadets at Lackland Air Force Base, San Antonio, Texas. The test scores were intercorrelated, and the resulting matrix of correlation coefficients was factor-analyzed. A variation of the multiple-grouping method of analysis was used, with the solution being iterated twice to stabilize both the communalities and the weights applied to the variables. The resulting factor matrix was then rotated to oblique simple structure. Eleven factors were found in this battery of 40 tests. The computation of the correlation coefficients and the extraction of factors were carried out on the I.B.M. Card-Programmed Calculator at the Forrestal Research Center of Princeton University; the rotation of axes was accomplished by use of the Matrix Rotator at The Adjutant General's Office in Washington, D. C.

Three of the eleven factors, Rote Memory, Meaningful Memory, and Span Memory, are rather clearly-defined memory factors; the fourth memory factor is not so clear-cut. The reference tests clearly identify three other factors as Verbal Comprehension, Numerical Facility, and Perceptual Speed. The eighth factor is a doublet representing the

specific variance of tests 3 and 22, which are parallel tests. The remaining three factors all appear to involve visual tasks; these factors seem to represent Visualization, Spatial Relations, and Visual Memory, but the identifications are uncertain since there seems to be confounding with Deduction and Psychomotor Coordination factors.

The conclusions drawn from this study may be stated as follows:

1. Factors were found which correspond to the hypothesized factors of Rote Memory, Meaningful Memory, and Span Memory. The fact that Rote Memory is distinct from Meaningful Memory has been suggested before, e.g., Katona (42), McGeoch (49), Jones (38), but never clearly demonstrated by factor-analytic techniques. Also, the separation of Span Memory from Rote Memory was suspected but not too convincingly demonstrated, e.g., French (21, p. 220 and p. 246), Jones (38).

2. All three of these factors are general for both visual and auditory presentation of material.

3. Both Rote Memory and Meaningful Memory are general for the three types of tests used—recognition, completion recall, and free recall; Span Memory is possibly restricted to free recall tests.

4. Meaningful Memory is probably general for both verbal and non-verbal material, while Rote Memory and Span Memory are possibly restricted to verbal material.

5. The evidence with regard to the hypothesized factor of Visual Memory is equivocal; neither positive nor negative conclusions about it may be drawn.

6. The possibility of an Auditory Memory factor is suggested by this analysis.

B. Recommendations for Further Research

Many problems on which further research is needed have been sug-
gested by this study; these problems seem to fall into six categories.
The categories, together with some of the areas for study within each
category, will be given below.

1. Test development. Much time could be spent profitably in re-
vising and improving the tests used in this study. For one thing, the
difficulty level of several of the tests needs to be adjusted; test 3
was too difficult for this population, while tests 4, 6, 13, 15, 16,
and 17 were too easy.

As in most large factor analysis studies, the tests used in this
investigation were all very short because of limitations in testing
time; this shortness tends to make the tests less reliable. As was
pointed out in Chapter III, the communality estimate for each test is
a lower-bound estimate of the reliability of that test; a look at
these communality estimates in Table C-11 shows that while most of the
tests were satisfactorily reliable, some possibly were not. It is
likely that the factor content of the tests which had extremely low
communalities in this study would be clarified if the tests were made
more reliable; hence one important step in further research would be
to check directly the reliabilities of the memory tests used in this
study, particularly those tests with low communalities, and to make
improvements in the tests in order to raise the reliabilities where
necessary.

2. Clarification of factors. To clarify the nature of the
Rote Memory factor, it would be desirable to develop additional
recognition and free recall tests to measure Rote Memory; also it is

necessary to determine whether or not this factor can be measured by the use of non-verbal material.

With regard to the Meaningful Memory factor, an attempt should be made to construct other recognition and free recall tests which will measure it better than did the tests of these kinds used in this study. It is possible, of course, that the test revision recommended in (1) above will itself raise the factor coefficients of the recognition and free recall tests which were measures of Meaningful Memory in this study. Another point which needs to be checked is whether or not this factor can be measured by non-verbal material. The most critical problem, however, is to design experiments which will distinguish between different possible definitions of "meaning."

The nature of the Span Memory factor needs to be clarified by answers to the questions as to whether or not this factor can be measured only by free recall tests, and whether or not it can be measured only by verbal material.

It might well prove helpful in investigating the nature of all of these factors to get introspective reports from subjects who are either very high or very low on one or more of these factors.

3. Identification of new factors. Another study is necessary to answer the question as to the existence of a Visual Memory factor; this new study should include improved forms of the tests used in this study which were intended to be measures of Visual Memory, additional new tests also specifically constructed to measure Visual Memory, and reference tests which will clearly separate out the variance due to the previously discriminated factors of Spatial Relations and Visualization.

This study has suggested the possibility of an Auditory Memory factor; attempts should be made to clarify further the nature of this factor and to determine whether or not it is limited to verbal tests. It is possible that this factor might be related to one or more of Karlin's factors (40, 41); in any case, further investigation is needed into the nature of auditory memory factors and their relationship to other memory factors.

If it is possible to demonstrate the existence of Visual Memory and Auditory Memory factors, might it not also be possible to find one or more Kinesthetic Memory factors? This is another possibility which should be explored.

4. Validity studies. It is highly probable that measures of these different memory factors will be useful in many problems of differential prediction of human behavior; in particular, they will probably improve our ability to make differential predictions of success or failure in educational and occupational situations. A number of validity studies are needed to explore these possibilities.

5. Testing methods. Investigation is needed in order to determine the effect of the method of testing on the factor content of the memory tests. In particular, three methods might be investigated.

The first method is one used to measure learning; traditionally learning has been measured by some variable such as amount of time or number of trials required by the subject to reach an arbitrarily defined criterion of learning. A better method, however, would be to plot an individual learning curve for each subject and to define the learning score or scores in terms of the parameters of that curve. If such parameters were used as scores, individual testing would probably be necessary.

The second testing method is one used to test forgetting; traditionally forgetting has been measured by the amount retained by the subject at the end of a fixed interval of time after some arbitrarily defined criterion of learning has been reached. Probably the best way to establish the criterion of learning would be to plot a learning curve for each subject and to define the criterion in terms of the parameters of that curve. It would also be possible to plot an individual forgetting curve for each subject and to use the parameters of that curve as scores for forgetting. Again individual testing would probably be necessary.

In the third testing method it is the amount retained by each subject at the end of an allotted amount of study time that is measured; this is the method most often used in group testing. In this method each subject is free to allocate his study time for a test in the way which seems to him to be most advantageous rather than being forced to allocate it in accordance with a schedule which has been predetermined by the experimenter.

A comparison of the factor content of memory tests administered by these three testing methods should be helpful in interpreting the nature of the factors themselves as well as in relating and interpreting the results of the many studies which have used these methods.

6. Other types of memory. This study dealt only with relatively immediate intentional retention; work needs to be done on both incidental memory and long-term memory. Questions as to how many factors are involved in each of these domains and as to whether the nature of those factors will be similar to, or different from, those found in the domain of immediate intentional memory remain to be answered.

BIBLIOGRAPHY

1. Abelson, A. R. The measurement of mental ability of 'backward' children. _Brit. J. Psychol._, 1911, _4_, 268-314.

2. Achilles, E. M. Experimental studies in recall and recognition. _Arch. Psychol._, 1920, _6_, No. 44.

3. Anastasi, A. A group factor in immediate memory. _Arch. Psychol._, 1930, _18_, No. 120.

4. Anastasi, A. Further studies on the memory factor. _Arch. Psychol._, 1932, _22_, No. 142.

5. Austin, S. D. M. A study in logical memory. _Amer. J. Psychol._, 1921, _32_, 370-403.

6. Bartlett, F. C. _Remembering_. London: Cambridge Univ. Press, 1932.

7. Bennett, F. The correlations between different memories. _J. exper. Psychol._, 1916, _1_, 404-419.

8. Blankenship, A. B. Memory span: A review of the literature. _Psychol. Bull._, 1938, _35_, 1-25.

9. Bolton, E. B. The relation of memory to intelligence. _J. exper. Psychol._, 1931, _14_, 37-67.

10. Brener, R. An experimental investigation of memory span. _J. exper. Psychol._, 1940, _26_, 467-482.

11. Bronner, A. F., Healy, W., Lowe, G. M., & Shimberg, M. E. _A manual of individual mental tests and testing_. Boston: Little, Brown, 1932.

12. Bryan, A. I. Organization of memory in young children. _Arch. Psychol._, 1934, _24_, No. 162.

13. Carey, N. Factors in the mental processes of school children, Part I. Brit. J. Psychol., 1914-1915, 7, 453-490.

14. Carey, N. Factors in the mental processes of school children, Part II. Brit. J. Psychol., 1915-1917, 8, 70-92.

15. Carlson, H. B. Factor analysis of memory ability. J. exper. Psychol., 1937, 21, 477-492.

16. Carothers, F. E. Psychological examinations of college students. Arch. Psychol., 1921, 6, No. 46.

17. Cook, S. W. (Ed) Psychological research on radar observer training. Army Air Forces Aviation Psychology Program Research Reports, Report No. 12. Washington: U. S. Government Printing Office, 1947.

18. Davis, R. A., & Moore, C. C. Methods of measuring retention. J. gener. Psychol., 1935, 12, 144-155.

19. Ebbinghaus, Hermann. Memory (trans. by H. A. Ruger and C. E. Bussenius). New York: Teachers College, Columbia Univ., 1913.

20. Eysenck, H. J., & Halstead, H. The memory function: I. A factorial study of fifteen clinical tests. Amer. J. Psychiat., 1945, 102, 174-180.

21. French, J. W. The description of aptitude and achievement tests in terms of rotated factors. Psychometric Monogr., 1951, No. 5.

22. French, J. W. Validation of new item types for the Scholastic Aptitude Test of the College Entrance Examination Board. Res. Bull., RB-53-19, Educational Testing Service, 1953.

23. Fruchter, B. Differences in factor content of rights and wrongs scores. Psychometrika, 1953, 18, 257-265.

24. Garrett, H. E. The relation of tests of memory and learning to each other and to general intelligence in a highly selected adult group. J. educ. Psychol., 1928, 19, 601-613.

25. Garrett, H. E. Differentiable mental traits. Psychol. Rec., 1938, 2, 259-298.

26. Grant, M. E. Some theories and experiments in the field of memory. J. educ. Psychol., 1932, 23, 511-527.

27. Guilford, J. P. (Ed.) Printed classification tests. Army Air Forces Aviation Psychology Program Research Reports, Report No. 5. Washington: U. S. Government Printing Office, 1947.

28. Guilford, J. P., & Dallenbach, K. M. The determination of memory span by the method of constant stimuli. Amer. J. Psychol., 1925, 36, 621-628.

29. Guillet, C. A study of the memory of young women. J. educ. Psychol., 1917, 8, 65-84.

30. Hawkins, C. J. Experiments on memory types. Psychol. Rev., 1897, 4, 289-294.

31. Henmon, V. A. C. The relation between mode of presentation and retention. Psychol. Rev., 1912, 19, 79-96.

32. Hollingworth, H. L. Characteristic differences between recall and recognition. Amer. J. Psychol., 1913, 24, 532-544.

33. Holzinger, K. J. Relationships between three multiple orthogonal factors and four bi-factors. J. educ. Psychol., 1938, 29, 513-519.

34. Holzinger, K. J., & Harman, H. H. Comparison of two factorial analyses. Psychometrika, 1938, 3, 45-60.

35. Holzinger, K. J., & Swineford, F. A study in factor analysis: The stability of a bi-factor solution. Suppl. Educ. Monogr., 1939, No. 48.

36. Husband, R. W. Intercorrelations among learning abilities.

    J. genet. Psychol., 1939, 55, 353-364.

37. Johannsen, D., Sterling, M., & Levine, J. An experiment on types

    of memory ability. J. educ. Psychol., 1932, 23, 28-34.

38. Jones, L. V. Primary mental abilities in the Stanford-Binet, age

    13. Psychometric Laboratory Report, No. 71, Univ. Chicago,

    1951.

39. Jones, M. G., & English, H. B. Notational vs. rote memory. Amer.

    J. Psychol., 1926, 37, 602-603.

40. Karlin, J. E. Music ability. Psychometrika, 1941, 6, 61-65.

41. Karlin, J. E. A factorial study of auditory function. Psycho-

    metrika, 1942, 7, 251-279.

42. Katona, G. Organizing and memorizing. New York: Columbia Univ.

    Press, 1940.

43. Kelley, H. P. An investigation to identify and analyze a Spatial-

    Relations factor in an airman population. Unpublished M.A.

    thesis, Univ. of Texas, 1951.

44. Kelley, T. L. Crossroads in the mind of man. Stanford: Stan-

    ford Univ. Press, 1928.

45. Klüver, H. Eidetic imagery. In A handbook of child psychology

    (Rev. Ed.). (C. Murchison, Ed.) Worcester: Clark Univ.

    Press, 1933, pp. 699-722.

46. Knott, J. R., Umberger, J. P., & Bilodeau, I. M. The application

    of an experimental "memory battery" in the psychiatric

    clinic. J. clin. Psychol., 1952, 8, 355-361.

47. Krueger, F., and Spearman, C. Die Korrelation zwischen

    verschiedenen geistigen Leistungsfähigkeiten. Z. f. Psychol.,

    1907, 44, 50-114.

48. Kuhlmann, F. The present status of memory investigation. _Psychol._ _Bull._, 1908, 5, 285-293.

49. McGeoch, J. A. Memory. _Psychol. Bull._, 1928, 25, 513-549.

50. Melton, A. W. (Ed.) _Apparatus tests._ Army Air Forces Aviation Psychology Program Research Reports, Report No. 4. Washington: U. S. Government Printing Office, 1947.

51. Rimoldi, H. J. A. Study of some factors related to intelligence. _Psychometrika_, 1948, 13, 27-46.

52. Sharp, A. A. The diagnostic significance of a visual memory drawing test. _J. abnorm. soc. Psychol._, 1949, 44, 517-527.

53. Sleight, W. G. Memory and formal training. _Brit. J. Psychol._, 1911, 4, 386-457.

54. Spearman, C. _The abilities of man._ New York: Macmillan, 1927.

55. Spearman, C., & Jones, L. W. _Human ability._ London: Macmillan, 1950.

56. Swineford, F., & Holzinger, K. J. A study in factor analysis: The reliability of bi-factors and their relation to other measures. _Suppl. Educ. Monogr._, 1942, No. 53.

57. Taylor, C. W. A factorial study of fluency in writing. _Psychometrika_, 1947, 12, 239-262.

58. Thurstone, L. L. Primary mental abilities. _Psychometric Monogr._, 1938, No. 1.

59. Thurstone, L. L. The perceptual factor. _Psychometrika_, 1938, 3, 1-17.

60. Thurstone, L. L. Theories of intelligence. _Psychometric Laboratory Report_, No. 18, Univ. Chicago, 1945.

61. Thurstone, L. L. Multiple-factor analysis. Chicago: Univ. Chicago Press, 1947.

62. Thurstone, L. L. Psychological implications of factor analysis. Psychometric Laboratory Report, No. 44, Univ. Chicago, 1947.

63. Thurstone, L. L. Mechanical aptitude III: Analysis of group tests. Psychometric Laboratory Report, No. 55, Univ. Chicago, 1949.

64. Thurstone, L. L. An analysis of mechanical aptitude. Psychometric Laboratory Report, No. 62, Univ. Chicago, 1951.

65. Thurstone, L. L., & Thurstone, T. G. Factorial studies of intelligence. Psychometric Monogr., 1941, No. 2.

66. U. S. Office of Strategic Services, Assessment Staff. Assessment of men. New York: Rinehart, 1948.

67. U. S. War Department, Research Study (WSW 2501). The interrelations among learning ability, aptitude, intelligence, and achievement measures. June 1, 1949--June 30, 1950 (mimeo.).

68. Vernon, P. E. The measurement of abilities. London: Univ. London Press, 1940.

69. Vernon, P. E. The structure of human abilities. London: Methuen, 1950.

70. Wechsler, D. Wechsler Memory Scale. New York: Psychol. Corp., 1945.

71. Welborn, E. L., & English, H. B. Logical learning and retention: A general review of experiments with meaningful verbal materials. Psychol. Bull., 1937, 34, 1-20.

72. Whipple, G. M. Manual of mental and physical tests. Baltimore: Warwick & York, 1910.

73. Wissler, C. The correlation of mental and physical tests. Psychol. Monogr., 1901, 3, No. 16.

74. Wolfle, D. Factor analysis to 1940. Psychometric Monogr., 1940, No. 3.

75. Woodrow, H. The common factors in fifty-two mental tests. Psychometrika, 1939, 4, 99-108.

76. Worcester, D. A. Memory by visual and by auditory presentation. J. educ. Psychol., 1925, 16, 18-27.

77. Zachert, V., & Friedman, G. The stability of the factorial pattern of aircrew classification tests in four analyses. Psychometrika, 1953, 18, 219-224.

78. Zimmerman, W. S. A revised orthogonal rotational solution for Thurstone's original Primary Mental Abilities test battery. Psychometrika, 1953, 18, 77-93.

APPENDIX A

Directions for Experimental Tests

1. Memory for Limericks Test
2. Letter Span Test I (Visual)
3. Memory for Syllables Test I
4. Consequences Test I
5. Number Span Test I (Auditory)
6. Memory for Words Test I (Unrelated words)
7. Recognition Test I (Syllables)
8. Memory for Ideas Test (Story)
9. Map Memory Test I (Reproduction)
10. Number Span Test II (Visual)
11. Meaningful Memory: Picture Test
12. Meaningful Memory: Paragraph Test
13. Meaningful Memory: Number Test
14. Letter Span Test II (Auditory)
15. Reproduction of Visual Designs Test
16. Consequences Test II (Verbal)
17. Recognition Test II (Words)
18. Memory for Numbers Test
19. Map Memory Test II (Verbal)
20. Map Memory Test III (Recognition)
21. Sentence Span Test
22. Memory for Syllables Test II
23. Recognition Test III (Figures)
24. Memory for Relations Test
25. Sentence Completion Test
26. Memory for Instructions Test
27. Memory for Words Test II (Related words)

NAME
(PRINT) Last   First   Middle

BOOK I

Form AETL1

This book contains 6 tests. The examiner will tell you
when to begin and end each test. During the time allowed
for one test you are to work <u>only</u> on it. Do not turn back
to a test after the time for that test is over.

For all the tests in this book you are to mark your answers
in the spaces provided in the book.

There are several types of tests. You will find special
directions for each type. <u>Be sure you understand the direc-</u>
<u>tions before attempting to answer any questions.</u>

DO NOT BREAK THE SEAL UNTIL YOU ARE TOLD TO DO SO.

952

MEMORY FOR LIMERICKS TEST

Directions

In this test you will be given 5 minutes to study a group of 30 limericks. Later you will be given the first four lines of each limerick, and your task will be to fill in the correct last line.

For example, you will study limericks like the following:

> There was a young lady from Niger
>
> Who smiled as she rode on a tiger.
>
> They returned from the ride
>
> With the lady inside
>
> And the smile on the face of the tiger.

Later you will turn to the answer page which contains only the first four lines of each limerick, like this:

> There was a young lady from Niger
>
> Who smiled as she rode on a tiger.
>
> They returned from the ride
>
> With the lady inside

In the blank space you are to write the last line exactly as it was in the original limerick. If you do not remember the exact words, write the line down as best you remember it; but try to remember the exact words, if possible.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

LETTER SPAN TEST I

Directions

In this test, the examiner will hold up a card containing a series of letters. The letters will be unrelated to each other. When the examiner removes the card from sight, you are to write down the letters in the exact order in which they were printed on the card. Do not write any letters until the examiner has taken away the card.

For example, the examiner might call out, "Series One," and then hold up a card like this:

```
┌─────────────┐
│             │
│   H  R  L   │
│             │
└─────────────┘
```

When he removes the card from sight and says, "Now," print the letters on the answer page in this manner:

1. H R L

Only the following letters will be used: C, F, G, H, K, L, P, R, S, W, Y.

Some of the series will be too long for you to remember all of the letters. If you do not remember some of them, leave a blank space for them and put down all the letters you do remember. Try to remember all the letters if possible, and be sure to write them down so that they will be in the exact order in which they were printed on the card.

In this test it is very important that no letters be written while the letters are being shown on the card, since the test is intended to measure memory for letters.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NOTE 1: Oral Directions for <u>LETTER SPAN TEST I</u>

Subsequent to the preparation of the test booklets, it was de-
cided to administer <u>Letter Span Test I</u> in a different manner from that
indicated in the directions on the preceding page. Therefore, after
the examinees read the directions in the test booklet they were given
the following instructions by the examiner:

> There is a slight change in the directions for this test.
> Instead of showing you all the letters in a letter-span
> set on one card, I will show you the letters one at a time
> on separate cards. For example, if the practice problem
> on the direction page were the first letter-span set in the
> test, I would call out "Series one." Then I would show
> you the letters in the series like this.

The examiner then demonstrated the technique of presentation to
be used. After showing the last card, he said:

> After I have showed you the last card in each series I will
> say "Now," and you are to write down as many of the letters
> as you can remember.

After answering all questions, the examiner proceeded with the ad-
ministration of the test.

MEMORY FOR SYLLABLES TEST I

Directions

In this test you will be given 1 minute to study 6 pairs of nonsense syllables. Each syllable is formed by placing a vowel between two consonants. You are to memorize the syllables so that when the first syllable of the pair is given you can answer with the second syllable of that pair.

For example, the following pairs are like the ones you will study:

L A J — F E H

G I W — Q A P

After studying the pairs for 1 minute you will be told to turn to the answer page. On it you will be given the first syllable in each pair. In the blank space after each syllable you are to write from memory the syllable which completes the pair.

The answer page for the pairs given above might look like this:

G I W —

L A J —

In the first blank you would write in the syllable "Q A P," and in the second blank the syllable "F E H." Notice that the pairs on the answer page will not be in the same order as the pairs on the study page.

This test will have two parts. The directions for each part are exactly the same—study the pairs, then fill in the blanks on the answer page.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

CONSEQUENCES TEST I

Directions

This is a test of your ability to remember and complete stories told in the form of a cartoon strip. The stories are not intended to be funny. Look at this pair of pictures and try to remember both of them.

A   B
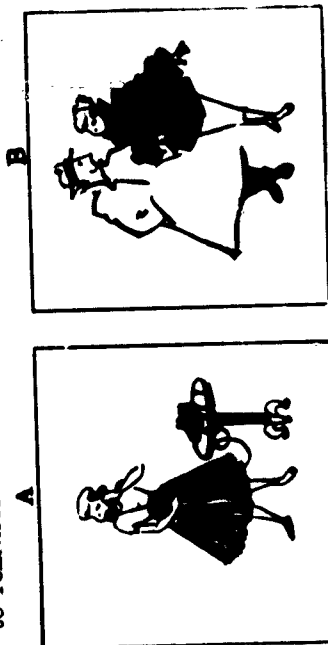
Now look at these pictures. Which one of the 3 pictures on the right correctly completes the story told in both pictures A and B above?

C-1   C-2   C-3
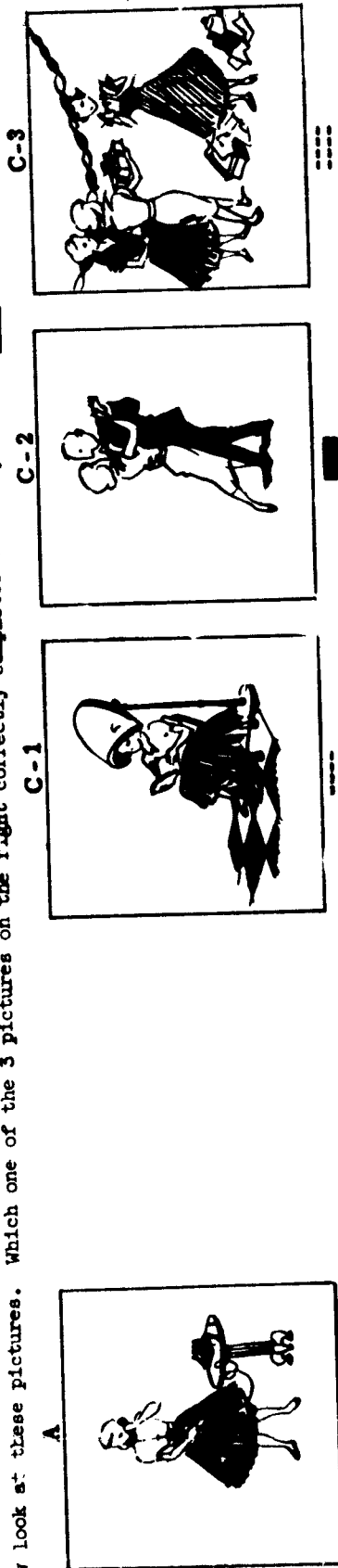
The space between the lines under picture C-2 has been blackened because it is the only picture that follows both A and B.

Look at this pair of pictures.

A   B
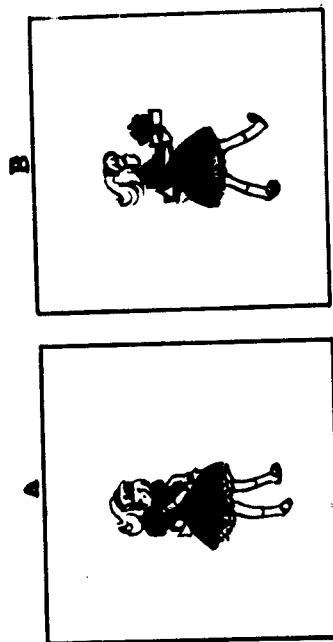
Now turn the page and blacken the space under the picture which correctly completes this story.

GO ON TO THE NEXT PAGE.

Look at picture A and, remembering what picture B was, blacken the space under the C picture which correctly completes the story.

You should have blackened the space under picture C-1, since neither C-2 nor C-3 goes with both the pictures in the second example on the preceding page.

Now study the following 4 pairs of pictures. Try to remember both pictures in each pair.

D

B

D

-54-

Look at picture A and, remembering what picture B was, underline the C picture which correctly completes the story.

D
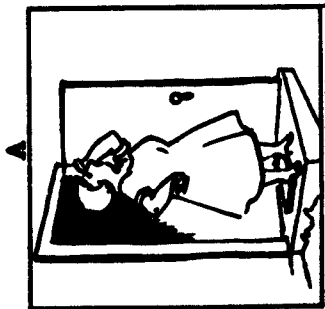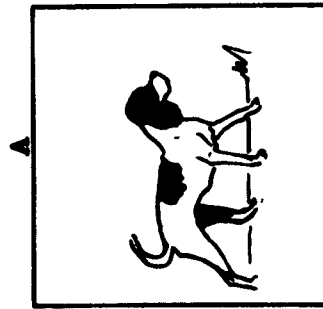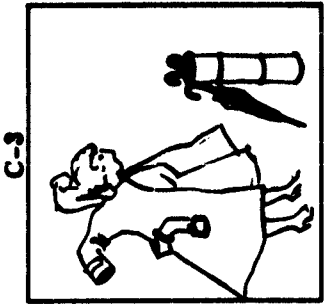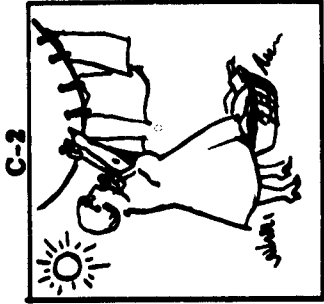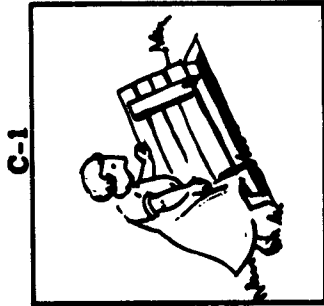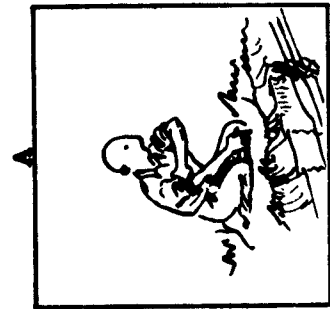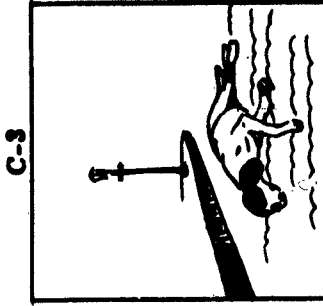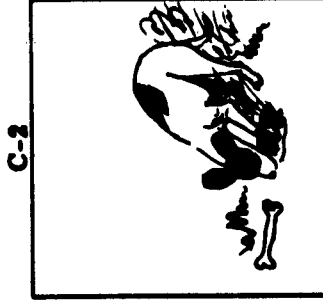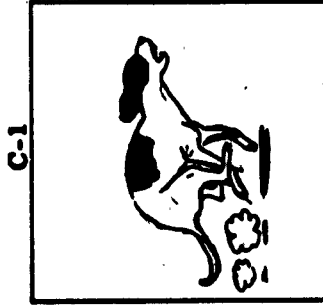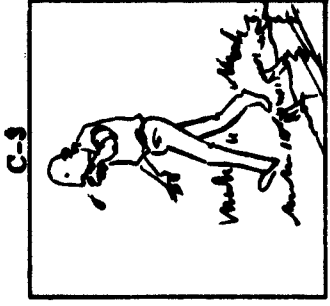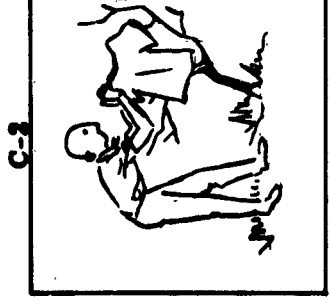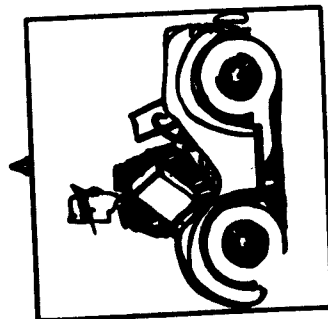
C-1   C-2   C-3

The correct answers are:

Problem 1, C-3
Problem 2, C-1
Problem 3, C-2
Problem 4, C-2
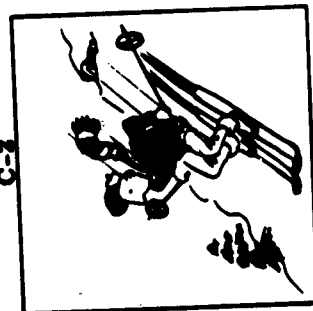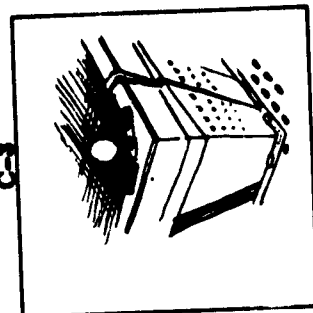
There will be 18 pairs of pictures for you to study and remember so that later you can choose the picture that correctly completes each pair. You will not be allowed to look back at the study page when you are marking your answers.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NUMBER SPAN TEST I

Directions

In this test, the examiner will call out a series of numbers. After he finishes, you are to write down the numbers in the exact order in which they were called out. Do not write any numbers until the examiner has finished the whole series.

For example, the examiner might call out, "Series One. 7 2 4 Now."

When he says, "Now," showing that the series is complete, write the numbers on the answer page in this manner:

1. 7 2 4

Some of the series will be too long for you to remember all of the numbers. If you do not remember some of them, leave a blank space for them and write down all the numbers you do remember. Try to remember all the numbers if possible, and be sure to write them down in the exact order in which they were called out.

It is very important that no numbers be written while the numbers are being called out, since the test is intended to measure memory for numbers.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MEMORY FOR WORDS TEST I

Directions

This is a test of your ability to remember pairs of unrelated words which you have heard. First the examiner will read aloud twice a list of 10 pairs of words. The list will not be read in the same order both times. After that, he will ask you to turn to the answer page. Then he will read aloud the first word of each pair. After each word is read, you are to write down the word which was paired with it in the list.

For example, the examiner will read out a list of pairs, like this:

First reading:	mule	— gold
	nail	— wren
	lark	— seal
Second reading:	lark	— seal
	nail	— wren
	mule	— gold

You would then turn to the answer page, which would look like this:

1. _____

2. _____

3. _____

The examiner would read out, "Number 1; nail," and you would then write the word "wren" in the first space. He would then read out, "Number 2; mule," and you would write the word "gold" in the second space. Then, "Number 3; lark," and you would write "seal."

Notice that the pairs will not be asked in either of the orders in which they were read.

This test will have two parts. The directions for each part are exactly the same—the examiner will read 10 pairs of words twice, then as he reads the first word of each pair again you are to write the second word of that pair on the answer page.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

BOOK II

Form AETL2

This book contains 7 tests. The examiner will tell you when
to begin and end each test. During the time allowed for one
test you are to work only on it. Do not turn back to a test
after the time for that test is over.

For all the tests in this book you are to mark your answers
in the spaces provided in the book.

There are several types of tests. You will find special
directions for each type. Be sure you understand the direc-
tions before attempting to answer any questions.

DO NOT BREAK THE SEAL UNTIL YOU ARE TOLD TO DO SO.

RECOGNITION TEST I

Directions

This is a test of your ability to recognize nonsense syllables which you have previously studied. Each syllable is formed by placing a vowel between two consonants. First you will study a list of 18 nonsense syllables. For example, the syllables you study will be like these:

L A J

G I W

After studying the list for 1 minute you will be told to turn to the answer page. On it you will be given a list of 36 syllables. The answer page might look like this:

```
              Yes   No
        G I W  ⊠ |   |
              Yes   No
        Q A P  |   | ⊠ |
              Yes   No
        F E H  |   |   |
              Yes   No
        L A J  |   |   |
```

You are to put a cross mark in the "YES" box by the syllable if that syllable was in the first list you studied; you are to put a mark in the "NO" box if it was not in the list you studied. The first two syllables have been marked correctly.

You will be allowed 1 minute to study the list of 18 nonsense syllables. You will NOT be allowed to refer back to the first list in answering the questions.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MEMORY FOR IDEAS TEST

Directions

This is a test of your ability to remember logically connected
material when it is read to you. First the examiner will read
aloud a very brief story entitled, "The Marble Statue." After
he finishes reading the story, you are to turn this page and
write down as much of the story as you can remember. You may
use your own words in writing the story, but try to remember as
many ideas and details as possible.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MAP MEMORY TEST I

Directions

In this test you will be asked to study a map and then to draw it from memory. First you will be given 2 minutes to study a map. Then you will turn to the answer page and draw the map as well as you can remember it. You will be scored on the number of details of the original map that you remember and also on whether or not each detail is put in approximately the correct place on the map.

You will have 2 minutes to study the map and 5 minutes to draw it. You will NOT be allowed to look back at the map after the 2-minute study period is over.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NUMBER SPAN TEST II

Directions

In this test, the examiner will hold up a card containing a series of numbers. The numbers will be unrelated to each other. When the examiner removes the card from sight, you are to write down the numbers in the exact order in which they were printed on the card Do <u>not</u> write any numbers until the examiner has taken away the card.

For example, the examiner might call out, "Series One," and then hold up a card like this:

```
┌─────────────────────────────┐
│           7  2  4           │
└─────────────────────────────┘
```

When he removes the card from sight and says, "Now," write the numbers on the answer page in this manner:

1. <u>7   2   4</u>

Some of the series will be too long for you to remember all of the numbers. If you do not remember some of them, leave a blank space for them and put down all the numbers you do remember. Try to remember all the numbers if possible, and be sure to write them down so that they will be in the <u>exact</u> order in which they were printed on the card.

<u>In this test it is very important that no numbers be written while the</u>
<u>numbers are being shown on the card, since the test is intended to</u>
<u>measure memory for numbers.</u>

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NOTE 2: Oral Directions for <u>NUMBER SPAN TEST II</u>

    <u>Number Span Test II</u> was administered in the same manner as <u>Letter</u>

<u>Span Test I</u>. After the examinees read the directions in the test

booklet (which are shown on the preceding page), they were given the

following instructions by the examiner:

> There is a slight change in the directions for this test.
> Instead of showing you all the numbers in a number-span set on
> one card, I will show you the numbers one at a time on
> separate cards. For example, if the practice problem on
> the direction page were the first number-span set in the
> test, I would call out "Series one." Then I would show you
> the numbers in the series like this.

    The examiner then demonstrated the technique of presentation to

be used. After showing the last card, he said:

> After I have showed you the last card in each series I will
> say "Now," and you are to write down as many of the numbers
> as you can remember. Are there any questions?

    After answering all questions, the examiner proceeded with the ad-

ministration of the test.

MEANINGFUL MEMORY TEST

Directions

In this test you will be given three different sets of material
to study. You will be allowed 5 minutes to study each set.
During the time allowed for one set of material you are <u>not</u> to
study either of the other two. The examiner will tell you when
to begin and end each one.

Later you will be asked questions concerning the material in
this test. You will <u>not</u> be allowed to see the original material
when you answer the questions.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NOTE 3: Directions for Study Pages of MEANINGFUL MEMORY TEST

The directions for each of the separate parts of the Meaningful Memory Test are given below. The directions were printed at the top of the study page for each part.

Part 1A: Picture

Time—5 minutes

Directions: Study the picture below. Later you will be shown a picture which is similar to this one but which differs from it in several respects, and you will be asked to compare the two. You will not be allowed to look back at the picture below when you are shown the second picture.

Part 2A: Paragraph

Time—5 minutes

Directions: Memorize as many of the facts in the following passage as you can in the time allowed. Later you will be asked to indicate whether statements made about the material in the passage are true or false. You will not be allowed to turn back to the passage.

Part 3A: Number

Time—5 minutes

Directions: Memorize as many of the numbers below as you can in the time allowed. Later you will be asked what the numbers are. You will not be allowed to turn back to the numbers.

LETTER SPAN TEST II

Directions

In this test, the examiner will call out a series of letters. After he finishes, you are to write down the letters in the exact order in which they were called out. Do <u>not</u> write any letters until the examiner has finished the whole series.

For example, the examiner might call out, "Series One.   H R L   Now."

When he says, "Now," showing that the series is complete, write the letters on the answer page in this manner:

1.   H R L

Only the following letters will be used: C, F, G, H, K, L, P, R, S, W, Y.

Some of the series will be too long for you to remember all of the letters. If you do not remember some of them, leave a blank space for them and write down all the letters you do remember. Try to remember <u>all</u> the letters if possible, and be sure to write them down in the <u>exact</u> order in which they were called out.

<u>As in the Number Span Test, it is very important not to write anything while the letters are being called out.</u>

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

REPRODUCTION OF VISUAL DESIGNS TEST

Directions

In this test, the examiner will hold up a card on which there will be a simple design. You are to study this design so that when it is removed, you can draw a copy of it. For example, one design might be like this:
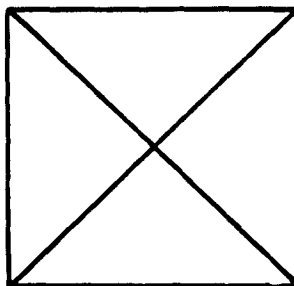
When the examiner removes the card containing the design, draw a copy of the design in the space indicated on the answer page. You may make the drawing any size you want, as long as it fits in the space provided, but try to reproduce the proportions and parts of the original design as well as possible. For example, these would be good copies:
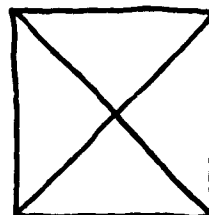
These would be poor copies:
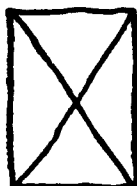
There will be ten designs. After each design has been removed, draw a copy of it. You will be allowed to study each design for only 5 seconds.

It is very important that you do not begin drawing until the examiner has removed the card containing the design, since this test is intended to measure your ability to remember the design.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MEANINGFUL MEMORY TEST

Directions

In this test you will be asked questions concerning the three sets
of material you studied previously. You will be allowed 5 minutes
for each part. During the time allowed for a part you are to work
on that part only. The examiner will tell you when to begin and end
each one.

Mark your answers to the questions in the test book in the spaces
indicated.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NOTE 4: Directions for Answer Pages of MEANINGFUL MEMORY TEST

The directions for each of the separate parts of the Meaningful Memory Test are shown below. The directions were printed at the top of the answer page for each part.

Part 1B: Picture

Time—5 minutes

Directions: The picture below (picture 2) is similar to the one which you saw earlier (picture 1), but you will observe that a number of changes have been made. Study picture 2 and then indicate whether each of the following statements is true or false.

Part 2B: Paragraph

Time—5 minutes

Directions: You are to decide whether each of the following statements is true or false according to the passage about . . . that you studied earlier.

Part 3B: Number

Time—5 minutes

Directions: The questions in this part are based on the numbers presented in connection with the sales at Miller's and Adams' Department Stores. For each question circle the answer you think is correct.

It will help you to write down in the space below all the numbers you can remember in connection with the sales before you attempt to answer the questions.

NAME _____
   (PRINT) Last   First   Middle

BOOK III

Form AFTL3

This book contains 12 tests. The examiner will tell you when to
begin and end each test. During the time allowed for one test
you are to work only on it. Do not turn back to a test after the
time for that test is over.

For all tests in this book you are to mark your answers in the
spaces provided in this book.

There are several types of tests. You will find special directions
for each type. Be sure you understand the directions before
attempting to answer any questions.

DO NOT BREAK THE SEAL UNTIL YOU ARE TOLD TO DO SO.

CONSEQUENCES TEST II

Directions

This is a test of your ability to remember relations. The examiner will read aloud 20 pairs of sentences. The two sentences in each pair will be related to each other. The following pairs are examples of what the 20 pairs will be like:

> The effect of the news was amazing.
> There was a great celebration.
>
> The little boy came into the house covered with dirt.
> He had been fighting again.

After all the pairs have been read, the examiner will read out the first sentence in each pair again. After the first sentence of the pair has been read, you are to write down the second sentence which completes the pair. It is not necessary to use the exact words of the second sentence, but try to write down the main idea it contained. The first sentences will not be re-read in the same order as the pairs were read.

For example, the examiner might read out the pairs given above. Then he would say, "Turn to the answer page. After I read out each sentence, write down the sentence which correctly completes the pair."

He would then read, "The little boy came into the house covered with dirt." Then you would write down something that said he had been fighting. The following sentence would be an acceptable answer: "He had gotten dirty while he was fighting."

Then the examiner would read, "The effect of the news was amazing." Any answer saying that there had been a big celebration would be correct.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

RECOGNITION TEST II

Directions

This is a test of your ability to remember and recognize words. First the examiner will read aloud a list of 25 unrelated words. After that, he will ask you to turn to the answer page. Then he will read aloud a list of 50 words. After each word is read, you are to mark "Yes" if that word was in the first list of 25 words, or mark "No" if it was not in the first list.

For example, the first list of words might be like this:

> oven
> player

You would then turn to the answer page, which would look like this:

	Yes	No
1.		
2.		
3.		
4.		

The examiner would then read out a list of words. The first word might be "caution." Since this word was not in the first list, you should put a mark in the "No" box opposite the number 1. The whole list of words might be:

> caution
> player
> oven
> basket

The answer page, correctly marked, would look like this:

	Yes	No
1.		X
2.	X	
3.	X	
4.		X

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MEMORY FOR NUMBERS TEST

Directions

In this test you will be given 1 minute to study 12 pairs of words and numbers. Each pair will consist of a word followed by a number. You are to memorize the pairs so that when the word is given you can answer with the number which correctly completes the pair.

For example, the following pairs are like the ones you will study:

bird — 49

core — 17

time — 83

After studying the pairs for 1 minute you will be told to turn to the answer page. On it you will be given the word in each pair. In the blank space after each word you are to write from memory the number which completes the pair.

The answer page for the pairs given above might look like this:

core — _____

time — _____

bird — _____

In the first blank you would write the number "17," in the second blank the number "83," and in the third blank the number "49." Notice that the pairs on the answer page will not be in the same order as the pairs on the study page.

This test will have two parts. The directions for each part are exactly the same—study the pairs, then fill in the blanks on the answer page.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MAP MEMORY TEST II

Directions

In this test you will be given a map to study; then you will be asked questions about it which must be answered from memory. The questions may be about:

1. The names of places and things.
2. The location of places and things in relation to each other.
3. Routes from one place to another.
4. Compass directions.
5. The number of times certain objects occur in the map.

The following map is an example.

SAMPLE MAP
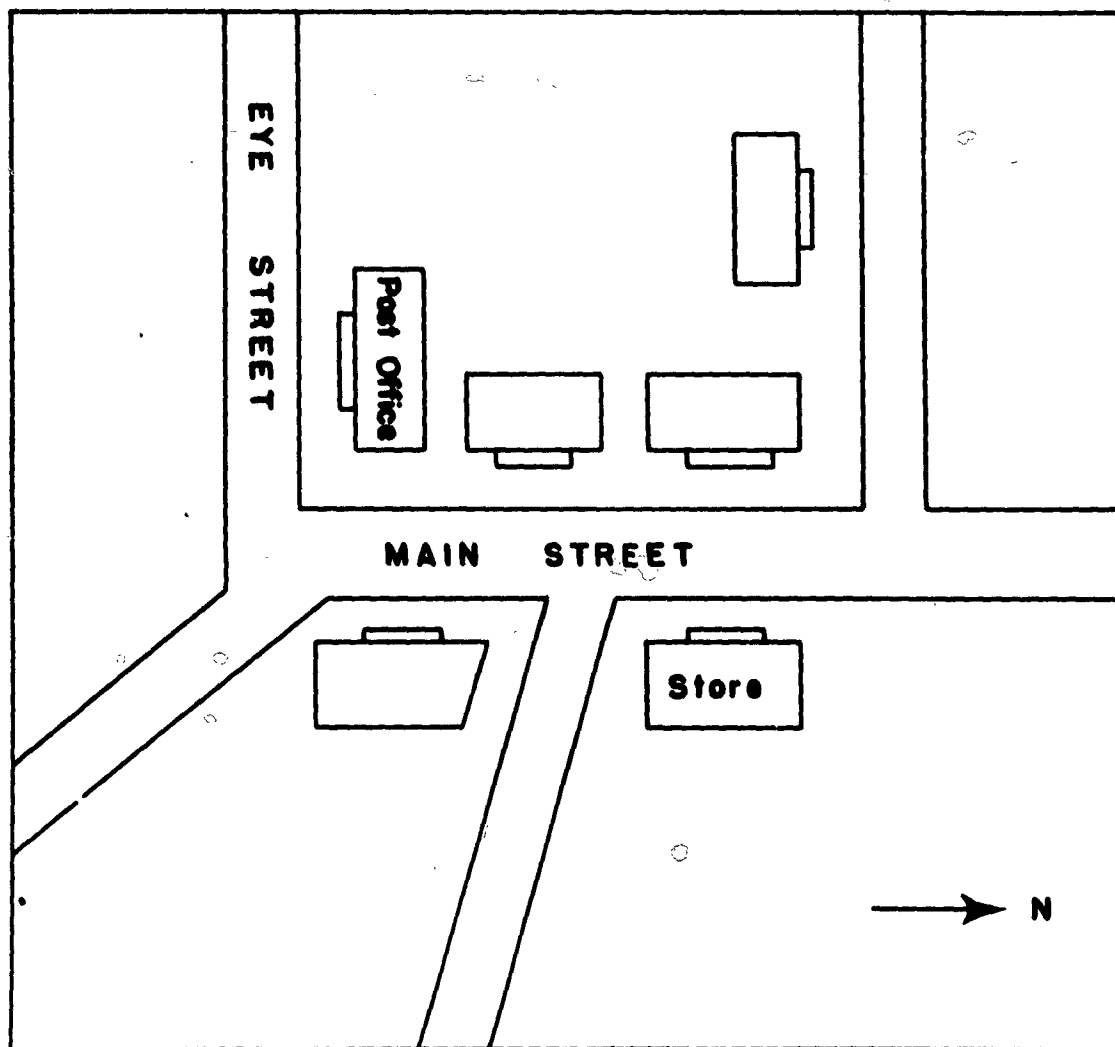
GO ON TO THE NEXT PAGE.

After studying the map you will turn the page and be asked to answer questions
like those below. Mark your answers by putting a circle around the letter of
the correct answer. Questions 1 and 2 have been marked correctly.

1. How many buildings face Main Street?

     (A) 2
     (B) 3
     (C) 4
     (D) 5
     (E) 6

2. On what street is the post office?

     (A) Main
     (B) King
     (C) Land
     (D) Bill
     (E) Eye

3. In what direction does the store face?

     (A) North
     (B) South
     (C) East
     (D) West
     (E) Southeast

4. What street must be crossed in going from the store to the post office?

     (A) Main
     (B) King
     (C) Land
     (D) Bill
     (E) Eye

You will not be able to look at the original map when you are answering the ques-
tions.

You will have 30 seconds to study the map and 3 minutes to mark your answers. Are
there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MAP MEMORY TEST III

Directions

The directions for this test are slightly different from those for the test you just finished. This is a test of your ability to recognize sections of a map. You will be given a map to study for 3 minutes. Then you will turn the page and answer questions based on the map.

Each question will consist of 5 pictures of one small section of the map. One of these 5 pictures will be an accurate picture of that section of the map. The other 4 pictures will contain wrong details such as misplaced crops, omitted roads, etc. You are to select the correct picture and blacken the space beneath it.

For example, the map might be like this:

SAMPLE MAP
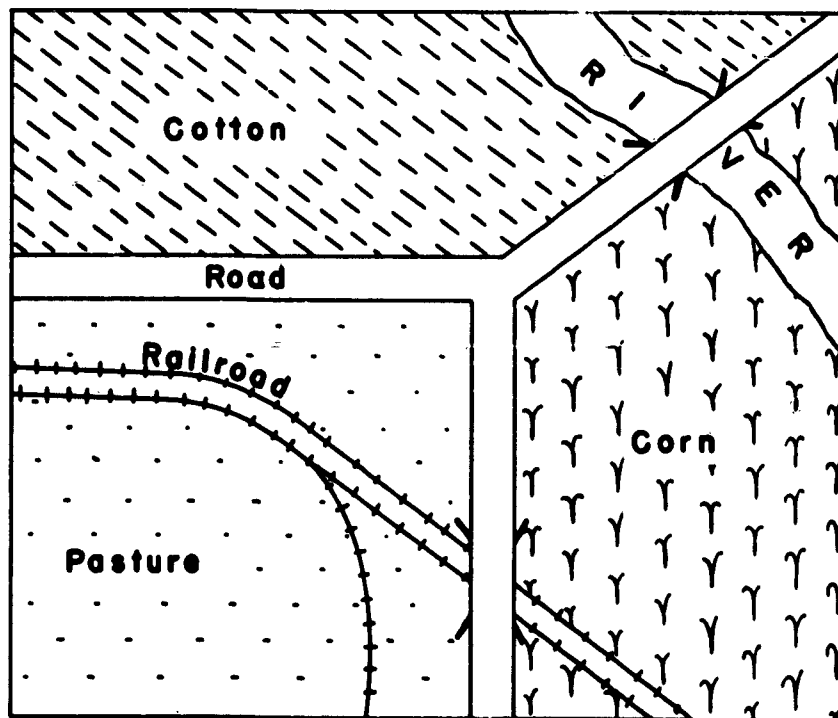
GO ON TO THE NEXT PAGE.

Two sample questions are shown below. In each question only one of the five
pictures was taken from the map given on the opposite page. You are to find
the picture which was taken from the map and blacken the space beneath that
picture. The correct answer to the first question has been marked. Mark
the correct answer to the second question.

1.

2.
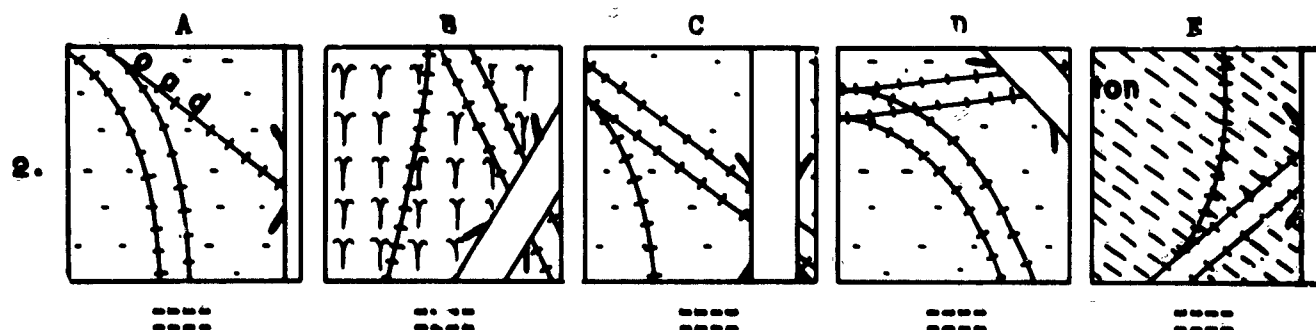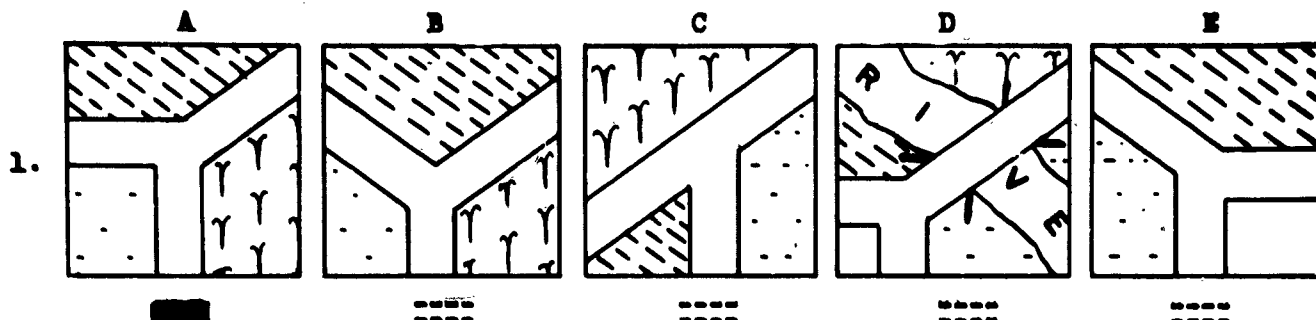
You should have blackened the space beneath picture C, since it shows
correctly an area of the map.

Remember, you will not be able to look at the original map when you are
answering the test questions.

You will have 3 minutes to study the map and 6 minutes to mark your answers.
Are there any questions.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SENTENCE SPAN TEST

Directions

This is a test of your ability to remember sentences which
you hear. The examiner will read aloud a list of sentences.
After each sentence he will pause, and you are to write down
the sentence exactly as it was read. Do not start writing
until the examiner has finished reading the sentence. If
you do not remember the whole sentence, write down as much
as you do remember. However, try to remember and·write down
the entire sentence.

There will be 16 sentences, and the directions for each
sentence are the same—do not start writing until the exam-
iner has finished reading the sentence, and be sure to write
down the exact words the examiner used. You will not be
graded on spelling or punctuation.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MEMORY FOR SYLLABLES TEST II

Directions

In this test you will be given 1 minute to study 6 pairs of nonsense syllables. Each syllable is formed by placing a vowel between two consonants. You are to memorize the syllables so that when the first syllable of the pair is given you can answer with the second syllable of that pair.

For example, the following pairs are like the ones you will study:

<div align="center">

L A J — F E H

G I W — Q A P

</div>

After studying the pairs for 1 minute you will be told to turn to the answer page. On it you will be given the first syllable in each pair. In the blank space after each syllable you are to write from memory the syllable which completes the pair.

The answer page for the pairs given above might look like this:

<div align="center">

G I W —

L A J —

</div>

In the first blank you would write in the syllable "Q A P," and in the second blank the syllable "F E H." Notice that the pairs on the answer page will not be in the same order as the pairs on the study page.

This test will have two parts. The directions for each part are exactly the same—study the pairs, then fill in the blanks on the answer page.

Are there any questions?

<div align="center">

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

</div>

RECOGNITION TEST III

Directions

This test is designed to measure your ability to recognize figures which you have previously studied. For example, study the following group of figures:

Now look at the figures and questions given below:

1.

Yes   No

2.

Yes   No

3.

Yes   No

4.

Yes   No

Place a check mark under "Yes" if the figure was one of those which you studied above. Place a check mark under "No" if the figure was NOT one of those which you studied above. In each case the question is, "Was this figure one of the figures in the group which you previously studied?" None of the figures will appear upside down or turned over on its side. Do not refer back to the first group of figures in answering the questions.

You should have checked "No" for the first figure, "Yes" for the second figure, "Yes" for the third, and "No" for the fourth.

You will be allowed 1 minute to study a group of 40 figures similar to these. The questions will consist of 80 figures. You are to answer each question with a "Yes" or a "No" as you did above. You will NOT be allowed to refer back to the first group in answering the questions.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MEMORY FOR RELATIONS TEST

Directions

This test will measure your ability to remember relations. First you will study
14 groups of figures similar to the following:

Sample Group A.

3	5	7
6	8	10
9	11	13

Sample Group B.

↑	→	↓
⊥	⊣	⊥
⊤	⊣	⊥

There are 9 figures to each group. Notice that in each group there are two rules
or relations. In the first group the rules are: going across, add 2; going down,
add 3. In the second group the rules are: going across, turn 90° to the right;
going down, straighten the arrowhead.

After studying the groups of figures for 6 minutes, you will turn to the answer page.
In each question you will be shown the figure in the upper left-hand corner of one of
the groups you studied. You are then to draw or write whichever of the other 8 figures
would be in the position indicated by the circle. For example, the answer page for the
groups above might look like this:

1.

↑	-	-
-	-	◯
-	-	-

2.

3	-	-
-	-	-
-	-	◯

In the first question, the figure of the arrow in the upper left-hand corner shows
that this is to be Sample Group B. In the circle in the first question you would
draw the third figure of the second row of that group—namely, the figure ⊥ . In
the second question you would write in the number in the lower right-hand corner of
Sample Group A—namely, the number 13 .

Notice that the answer to each question can be figured out by remembering the two
rules that apply to each group. This should be easier to do than trying to remember
all 9 figures of each group.

The answer page above, correctly marked, would look like this:

1.

↑	-	-
-	-	⊥̊
-	-	-

2.

3	-	-
-	-	-
-	-	(13)

You will have 6 minutes to study the 14 groups of figures. Then you will have about
10 minutes to answer the questions. You will not be able to look back at the original
groups when you are marking your answers.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SENTENCE COMPLETION TEST

This test is a sentence memory test. You will be given 4 minutes to study a group of 40 sentences. The sentences will then be presented to you in a different order with one word left out of each sentence. Your task is to write in the word which has been omitted.

The following two sentences are examples of the type of sentence you may expect.

> George's barn is red.
>
> The sun causes the trees to grow.

The answer page would then look like this:

> The _____ causes the trees to grow.
>
> George's barn is _____.

You would write the word "sun" in the blank space in the first sentence and the word "red" in the blank in the second sentence.

In the test proper you will not be allowed to refer back to the original sentences in filling in the blanks.

However, after you study the sentences, there will be a delay of about 10 minutes before you will fill in the blanks. During this time you will be taking another test. The directions for the other test will be given after you have studied the sentences for this test.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

MEMORY FOR INSTRUCTIONS TEST

Directions

This is a test of your ability to remember instructions which you hear. The examiner will read aloud several instructions. After he finishes the instructions, you are to carry them out.

For example, the examiner might say:

> Check the 9.
> Cross out the R.

The answer page might look like this:

> (a)   7   R   F   9
>
> (b)   7   R   F   9
>
> (c)   7   R   F   9

In row (a) you would carry out the first instruction—that is, you would check the 9. In row (b) you would cross out the R. The answer page, correctly marked, would look like this:

> (a)   7   R   F   9̸
>
> (b)   7   ✗   F   9
>
> (c)   7   R   F   9

In other words, you are to carry out the instructions in the order in which they were given, using a separate row on the answer page for each direction. Notice that there may be rows on the answer page for more instructions than you are given.

The instructions will all have to do with either letters or numbers. You may be asked to check, to circle, to underline, and to cross out.

There will be 16 sets of instructions. Remember, do not start carrying out a set of instructions until the examiner has finished reading that set, and be sure to carry them out in the exact order in which they were given.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NOTE 5: Directions for Answer Page of <u>SENTENCE COMPLETION TEST</u>

The directions given below were printed at the top of the <u>Sentence Completion Test</u> answer page, which followed the answer pages for the <u>Memory for Instructions Test</u>.

<u>SENTENCE COMPLETION TEST</u>

<u>Answer Page</u>

The sentences below are the ones you studied just a few minutes ago. Fill in the blank in each sentence with the word which was in it before.

Do <u>not</u> turn back to the previous study material in answering these questions.

MEMORY FOR WORDS TEST II

In this test you will be given 45 seconds to study 25 pairs of words. The words in each pair will be related to each other in some way. You are to memorize the words so that when the first word of the pair is given you can answer with the second word of that pair.

For example, the following pairs are like the ones you will study:

> dog — bark
>
> black — coal
>
> dirt — mud

After studying the pairs you will be told to turn to the answer page. On it you will be given the first word in each pair. In the blank space after each word you are to write from memory the related word which completes the pair.

The answer page for the pairs given above might look like this:

> 1. dirt —
>
> 2. dog —
>
> 3. black —

In the first blank you would write the word "mud," in the second blank the word "bark," and in the third blank the word "coal." Notice that the pairs on the answer page will not be in the same order as the pairs on the study page.

This test will have two parts. The directions for each part are exactly the same— study the pairs, then fill in the blanks on the answer page. Since you will have only 45 seconds to study each group of pairs, you will probably have to read them through fairly quickly.

Are there any questions?

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

APPENDIX B

Frequency Distributions of Test Scores

Table B-1   Memory for Limericks Test
       B-2   Letter Span Test I
       B-3   Memory for Syllables Test I
       B-4   Consequences Test I
       B-5   Number Span Test I.

       B-6   Memory for Words Test I
       B-7   Recognition Test I
       B-8   Memory for Ideas Test
       B-9   Map Memory Test I
      B-10   Number Span Test II

      B-11   Meaningful Memory: Picture Test
      B-12   Meaningful Memory: Paragraph Test
      B-13   Meaningful Memory: Number Test
      B-14   Letter Span Test II
      B-15   Reproduction of Visual Designs Test

      B-16   Consequences Test II
      B-17   Recognition Test II
      B-18   Memory for Numbers Test
      B-19   Map Memory Test II
      B-20   Map Memory Test III

      B-21   Sentence Span Test
      B-22   Memory for Syllables Test II
      B-23   Recognition Test III
      B-24   Memory for Relations Test
      B-25   Sentence Completion Test

      B-26   Memory for Instructions Test
      B-27   Memory for Words Test II
      B-28   Instrument Comprehension Test
      B-29   Mechanical Principles Test
      B-30   Rudder Control Test

      B-31   Complex Coordination Test
      B-32   Arithmetic Reasoning Test
      B-33   Reading Comprehension Test
      B-34   Vocabulary Test
      B-35   Dial and Table Reading Test

      B-36   Spatial Orientation Test I
      B-37   Coordinate Reading Test
      B-38   Discrimination Reaction Time Test
      B-39   Spatial Orientation Test II
      B-40   Numerical Operations Test.

TABLE B-1

Memory for Limericks Test

Score	Frequency
27	2
26	2
25	2
24	3
23	8
22	4
21	8
20	8
19	12
18	13
17	20
16	16
15	27
14	35
13	27
12	33
11	25
10	29
9	29
8	28
7	24
6	29
5	15
4	18
3	7
2	8
1	6
0	4
	442

Mean	11.56
S.D.	5.49

TABLE B-2

Letter Span Test I

Score	Frequency
16	2
14	7
13	5
12	15
11	43
10	56
9	81
8	90
7	67
6	44
5	22
4	9
2	1
	442
Mean	8.46
S.D.	2.11

TABLE B-3

Memory for Syllables Test I

Score	Frequency
10	8
9	14
8	11
7	18
6	45
5	70
4	71
3	83
2	61
1	54
0	7
	442
Mean	3.96
S.D.	2.21

TABLE B-4

Consequences Test I

Score	Frequency
18	59
17	105
16	93
15	58
14	36
13	30
12	22
11	6
10	15
9	10
8	3
7	2
6	1
5	2
	442

Mean	15.21
S.D.	2.50

TABLE B-5

Number Span Test I

Score	Frequency
17	1
14	2
13	5
12	12
11	23
10	27
9	52
8	76
7	84
6	77
5	49
4	24
3	7
2	2
1	1
	442

Mean	7.40
S.D.	2.23

TABLE B-6

Memory for Words Test I

Score	Frequency
20	30
19	24
18	30
17	31
16	32
15	32
14	27
13	39
12	37
11	33
10	21
9	26
8	20
7	16
6	13
5	9
4	12
3	6
2	2
1	2
	442

Mean	12.94
S.D.	4.56

Recognition Test I

Score	Frequency
36	2
34	7
33	7
32	27
31	17
30	38
29	19
28	61
27	32
26	41
25	32
24	53
23	14
22	35
21	14
20	17
19	6
18	5
17	4
16	1
15	3
14	1
12	2
11	2
9	1
6	1
	442

Mean	25.94
S.D.	4.36

TABLE B-8

Memory for Ideas Test

Score	Frequency
52	5
51	4
50	2
49	7
48	3
47	8
46	13
45	17
44	20
43	25
42	32
41	27
40	30
39	19
38	27
37	28
36	18
35	29
34	25
33	17
32	22
31	16
30	16
29	6
28	5
27	6
26	5
25	4
24	2
22	2
20	1
17	1
	442

Mean	37.98
S.D.	6.06

TABLE B-9

Map Memory Test I

Score	Frequency
56	3
55	1
54	2
53	4
52	7
51	17
50	17
49	21
48	23
47	26
46	38
45	39
44	31
43	20
42	28
41	21
40	25
39	21
38	15
37	16
36	20
35	7
34	10
33	11
32	6
31	1
30	4
29	5
27	1
25	1
24	1
	442

Mean	42.89
S.D.	5.72

TABLE B-10

Number Span Test II

Score	Frequency
17	1
15	4
14	6
13	22
12	23
11	44
10	67
9	62
8	56
7	67
6	52
5	27
4	7
3	4
	442

Mean	8.69
S.D.	2.45

TABLE B-11

Meaningful Memory: Picture Test

Score	Frequency
30	1
29	7
28	21
27	40
26	44
25	58
24	56
23	54
22	37
21	35
20	25
19	18
18	25
17	7
16	8
15	2
14	2
12	1
8	1
	442

Mean	23.18
S.D.	3.27

TABLE B-12

Meaningful Memory: Paragraph Test

Score	Frequency
29	6
28	13
27	34
26	53
25	52
24	61
23	51
22	55
21	33
20	35
19	22
18	10
17	7
16	4
15	4
14	2
	442

Mean	23.17
S.D.	2.93

TABLE B-13

Meaningful Memory: Number Test

Score	Frequency
15	105
14	58
13	55
12	56
11	46
10	33
9	30
8	22
7	13
6	8
5	6
4	3
3	4
2	3
	442

Mean	11.89
S.D.	2.91

TABLE B-14

Letter Span Test II

Score	Frequency
15	1
14	5
13	4
12	16
11	23
10	39
9	58
8	91
7	86
6	73
5	26
4	16
3	3
1	1
	442
Mean	7.84
S.D.	2.12

TABLE B-15

Reproduction of Visual Designs Test

Score	Frequency
20	57
19	88
18	74
17	75
16	59
15	37
14	26
13	16
12	7
11	2
10	1
	442
Mean	17.21
S.D.	2.08

TABLE B-16

Consequences Test II

Score	Frequency
20	86
19	89
18	83
17	58
16	38
15	29
14	21
13	12
12	11
11	3
10	2
9	2
8	4
7	2
6	1
2	1
	442

Mean	17.29
S.D.	2.69

TABLE B-17

Recognition Test II

Score	Frequency
50	16
49	19
48	27
47	28
46	52
45	39
44	42
43	32
42	35
41	33
40	26
39	17
38	21
37	17
36	10
35	7
34	5
33	4
32	8
31	2
30	1
29	1
	442
Mean	42.88
S.D.	4.37

TABLE B-18

Memory for Numbers Test

Score	Frequency
22	4
21	6
20	11
19	7
18	10
17	17
16	20
15	29
14	19
13	31
12	22
11	32
10	33
9	35
8	40
7	31
6	30
5	20
4	26
3	9
2	7
1	3
	442

Mean	10.60
S.D.	4.75

TABLE B-19

Map Memory Test II

Score	Frequency
11	1
10	5
9	14
8	42
7	59
6	83
5	74
4	75
3	59
2	24
1	4
0	2
	442

Mean	5.28
S.D.	1.95

TABLE B-20

Map Memory Test III

Score	Frequency
12	8
11	24
10	42
9	68
8	78
7	69
6	65
5	34
4	23
3	23
2	5
1	2
0	1
	442

Mean	7.31
S.D.	2.28

TABLE B-21

Sentence Span Test

Score	Frequency
15	5
14	9
13	12
12	29
11	53
10	54
9	55
8	72
7	56
6	37
5	27
4	14
3	15
2	1
1	2
0	1
	442
Mean	8.49
S.D.	2.70

TABLE B-22

Memory for Syllables Test II

Score	Frequency
12	8
11	14
10	23
9	23
8	36
7	40
6	53
5	48
4	60
3	63
2	41
1	23
0	10
	442
Mean	5.31
S.D.	2.87

TABLE B-23

Recognition Test III

Score	Frequency
79	2
76	2
74	5
73	10
72	9
71	16
70	25
69	20
68	20
67	25
66	22
65	27
64	26
63	25
62	23
61	22
60	21
59	20
58	33
57	14
56	16
55	9
54	10
53	6
52	10
51	5
50	5
49	4
48	8
47	2
	442

Mean	62.61
S.D.	6.37

TABLE B-24

Memory for Relations Test

Score	Frequency
14	10
13	31
12	74
11	64
10	62
9	61
8	43
7	45
6	28
5	11
4	4
3	5
2	2
1	1
0	1
	442
Mean	9.55
S.D.	2.50

TABLE B-25

Sentence Completion Test

Score	Frequency
36	3
34	2
33	5
32	6
31	6
30	11
29	13
28	13
27	17
26	11
25	22
24	25
23	20
22	18
21	18
20	33
19	20
18	26
17	26
16	25
15	19
14	20
13	15
12	22
11	7
10	11
9	9
8	3
7	9
6	3
5	1
4	1
3	1
1	1
	442

Mean	19.64
S.D.	6.64

TABLE B-26

Memory for Instructions Test

Score	Frequency
16	2
15	6
14	9
13	18
12	35
11	45
10	63
9	75
8	69
7	59
6	34
5	15
4	7
3	1
2	1
1	2
0	1
	442
Mean	9.01
S.D.	2.47

TABLE B-27

Memory for Words Test II

Score	Frequency
50	2
49	1
48	6
47	9
46	9
45	9
44	12
43	12
42	22
41	12
40	21
39	27
38	20
37	30
36	24
35	22
34	20
33	19
32	19
31	23
30	19
29	23
28	15
27	8
26	8
25	12
24	8
23	5
22	9
21	5
20	3
19	3
17	1
15	2
13	1
9	1
	442

Mean	34.71
S.D.	7.12

TABLE B-28

Instrument Comprehension Test

Score	Frequency
9	26
8	49
7	59
6	77
5	82
4	66
3	48
2	17
1	18
	442

Mean	5.36
S.D.	2.02

TABLE B-29

Mechanical Principles Test

Score	Frequency
9	38
8	34
7	49
6	84
5	96
4	55
3	50
2	33
1	3
	442

Mean	5.38
S.D.	1.98

TABLE B-30

Rudder Control Test

Score	Frequency
9	27
8	39
7	78
6	90
5	99
4	47
3	42
2	19
1	1
	442

Mean	5.63
S.D.	1.79

TABLE B-31

Complex Coordination Test

Score	Frequency
9	18
8	39
7	63
6	95
5	82
4	70
3	49
2	22
1	4
	442

Mean	5.36
S.D.	1.82

TABLE B-32

Arithmetic Reasoning Test

Score	Frequency
9	45
8	37
7	71
6	78
5	83
4	59
3	43
2	16
1	10
	442

Mean	5.63
S.D.	2.00

TABLE B-33

Reading Comprehension Test

Score	Frequency
9	25
8	50
7	54
6	93
5	96
4	57
3	43
2	18
1	6
	442

Mean	5.52
S.D.	1.86

TABLE B-34

Vocabulary Test

Score	Frequency
9	14
8	45
7	44
6	66
5	92
4	79
3	55
2	29
1	18
	442
Mean	4.99
S.D.	1.97

TABLE B-35

Dial and Table Reading Test

Score	Frequency
9	39
8	49
7	64
6	61
5	87
4	68
3	46
2	24
1	4
	442
Mean	5.55
S.D.	2.01

TABLE B-36

Spatial Orientation Test I

Score	Frequency
9	20
8	20
7	66
6	50
5	98
4	89
3	51
2	30
1	18
	442
Mean	4.93
S.D.	1.94

TABLE B-37

Coordinate Reading Test

Score	Frequency
9	26
8	23
7	39
6	68
5	89
4	76
3	49
2	31
1	41
	442
Mean	4.75
S.D.	2.14

TABLE B-38

Discrimination Reaction Time Test

Score	Frequency
9	30
8	44
7	59
6	86
5	98
4	61
3	33
2	20
1	11
	——
	442

Mean	5.51
S.D.	1.92

TABLE B-39

Spatial Orientation Test II

Score	Frequency
9	38
8	44
7	48
6	68
5	97
4	78
3	29
2	28
1	12
	——
	442

Mean	5.41
S.D.	2.03

Numerical Operations Test

Score	Frequency
9	12
8	21
7	72
6	81
5	103
4	90
3	27
2	29
1	7
	442

Mean	5.17
S.D.	1.72

APPENDIX C

Analysis of Complete Memory Battery

TABLE C-1

Descriptive Statistics of 40 Tests for 442 Subjects

Test	Total Possible Score	Mean	Standard Deviation
1. Memory for Limericks	30	11.56	5.49
2. Letter Span I (Visual)	18	8.46	2.11
3. Memory for Syllables I (Paired Associates: Nonsense Syllables)	12	3.96	2.21
4. Consequences I (Non-verbal)	18	15.21	2.50
5. Number Span I (Auditory)	18	7.40	2.23
6. Memory for Words I (Paired Associates: Unrelated Words	20	12.94	4.56
7. Recognition I (Syllables)	36	25.94	4.36
8. Memory for Ideas	67	37.98	6.06
9. Map Memory I (Reproduction)	56	42.89	5.72
10. Number Span II (Visual)	18	8.69	2.45
11. Meaningful Memory: Picture	30	23.18	3.27
12. Meaningful Memory: Paragraph	30	23.17	2.93
13. Meaningful Memory: Number	15	11.89	2.91
14. Letter Span II (Auditory)	18	7.84	2.12
15. Reproduction of Visual Designs	20	17.21	2.08
16. Consequences II (Verbal)	20	17.29	2.69
17. Recognition II (Words)	50	42.88	4.37
18. Memory for Numbers (Paired Associates: Unrelated Words and Numbers)	22	10.60	4.75
19. Map Memory II (Verbal Questions)	14	5.28	1.95
20. Map Memory III (Recognition)	12	7.31	2.28
21. Sentence Span	16	8.49	2.70
22. Memory for Syllables II (Paired Associates: Nonsense Syllables)	12	5.31	2.87
23. Recognition III (Figures)	80	62.61	6.37
24. Memory for Relations	14	9.55	2.50
25. Sentence Completion	40	19.64	6.64
26. Memory for Instructions (Span)	16	9.01	2.47
27. Memory for Words II (Paired Associates: Related Words)	50	34.71	7.12
28. Instrument Comprehension		5.36	2.02
29. Mechanical Principles		5.38	1.98
30. Rudder Control		5.63	1.79
31. Complex Coordination		5.36	1.82
32. Arithmetic Reasoning		5.63	2.00
33. Reading Comprehension		5.52	1.86
34. Vocabulary		4.99	1.97
35. Dial and Table Reading		5.55	2.01

TABLE C-1 (Continued)

Descriptive Statistics of 40 Tests for 442 Subjects

	Total Pos-sible Score	Mean	Standard Deviation
36. Spatial Orientation I		4.93	1.94
37. Coordinate Reading		4.75	2.14
38. Discrimination Reaction Time		5.51	1.92
39. Spatial Orientation II		5.41	2.03
40. Numerical Operations		5.17	1.72

TABLE C-2

Correlations of 40 Tests for 442 Subjects: Matrix R_o

(Decimal points omitted)

Test	1	2	3	4	5	6	7	8	9	10
1. Lim		2330	2463	2851	1628	2240	2253	5313	1142	2286
2. LSp-Vi	2330		2285	1701	4851	1722	1223	1435	1458	5185
3. PSyl-1	2463	2285		0808	2122	3930	2058	1436	1935	2798
4. Con-NV	2851	1701	0808		0817	1799	0722	2579	2325	1557
5. NSp-Au	1628	4851	2122	0817		2005	0781	1585	0756	5024
6. PWd-U	2240	1722	3930	1799	2005		2282	2519	2002	1908
7. RSyl	2253	1223	2058	0722	0781	2282		0934	1448	1053
8. Iders	5313	1435	1436	2579	1585	2519	0934		1729	1689
9. Map-Rp	1142	1458	1935	2325	0756	2002	1448	1729		1509
10. NSp-Vi	2286	5185	2798	1557	5024	1908	1053	1689	1509	
11. Pict	2224	2420	1789	1772	1966	1745	1804	2088	2120	2015
12. Para	3165	1773	1722	1671	0914	2434	2605	2160	2014	1460
13. Num	0138	1143	2166	1268	1621	2082	1804	0477	2454	2003
14. LSp-Au	2917	5455	2787	0711	5824	2761	1798	1749	1206	5303
15. DsgRp	1185	1588	1375	1603	1658	0746	1180	0820	2961	1627
16. Con-Vb	3955	1461	1999	1657	1099	2015	1614	3084	1130	1325
17. RWd	1022	0905	1526	0517	1082	4192	1622	1756	2105	1941
18. PNum	2118	2138	4216	1357	1690	4612	2387	1334	2976	1978
19. Map-Vb	1090	1069	1313	1046	1342	0774	1664	1115	1961	2037
20. Map-Rc	1576	2290	1604	1525	1456	1981	2228	1471	3052	1594
21. SenSp	3631	3494	2255	1888	3140	1526	1188	3176	-0402	2790
22. PSyl-2	2635	3108	5091	1446	2299	3077	2683	1498	2917	3317
23. RFig	2180	1101	1300	1933	0929	2123	2898	1848	2690	0470
24. Rel	1673	1271	1453	2217	1863	1938	1425	1220	2578	2040
25. SComp	4795	1277	3216	1773	1459	3765	2441	3397	2325	1570
26. InsSp	1027	2804	0793	0707	2300	-0497	-0245	-0334	0708	2912
27. PWd-R	2595	1929	3082	1635	1015	3949	2588	2049	2689	2295
28. IComp	1893	1460	1059	0953	1436	0893	1266	0495	1696	1047
29. MPrin	1541	0626	-0185	0056	1287	0707	0130	1510	1100	0529
30. RCon	-0956	1162	-0511	-0702	1041	0285	-0366	-0738	-0594	0257
31. CCoord	0981	1814	0203	0764	2040	0372	0895	1002	1324	1272
32. AReas	3347	1606	1279	1772	1985	1051	1723	1712	1853	2506
33. RdComp	4592	2060	1424	2038	1971	1476	2574	2624	1361	1655
34. Voc	5927	2972	2584	2516	2243	1419	2551	3399	1673	2138
35. DTRd	1345	1452	1475	1712	1646	-0001	1010	0725	2604	1746
36. SpaO-1	0530	1434	0892	1947	0793	-0445	-0085	0762	2791	1537
37. CRd	1008	0903	0365	1350	1403	-0093	1220	0618	2196	1412
38. DRTime	1224	2050	1178	1688	2118	1194	0828	0747	1984	1276
39. SpaO-2	0847	1412	0407	1659	0576	-0177	1043	0509	3040	1064
40. NumOp	2503	1564	1469	1834	1639	0441	1183	1033	1870	2441

TABLE C-2 (Continued)

Correlation of 40 Tests for 442 Subjects: Matrix R_o

(Decimal points omitted)

Test	11	12	13	14	15	16	17	18	19	20
1. Lim	2224	3165	0138	2917	1185	3955	1022	2118	1090	1576
2. LSp-Vi	2420	1773	1143	5455	1588	1461	0905	2138	1069	2290
3. PSyl-1	1789	1722	2166	2787	1375	1999	1526	4216	1313	1604
4. Con-NV	1772	1671	1268	0711	1603	1657	0517	1357	1046	1525
5. NSp-Au	1966	0914	1621	5824	1658	1099	1082	1690	1342	1456
6. PWd-U	1745	2434	2082	2761	0746	2015	4192	4612	0774	1981
7. RSyl	1804	2605	1804	1798	1180	1614	1622	2387	1664	2228
8. Ideas	2088	2160	0477	1749	0820	3084	1756	1334	1115	1471
9. Map-Rp	2120	2014	2454	1206	2961	1130	2105	2976	1961	3052
10. NSp-Vi	2015	1460	2003	5303	1627	1325	1941	1978	2037	1594
11. Pict		1935	2180	1849	2151	1806	1131	1617	0454	2669
12. Para	1935		2276	1878	0654	2321	1658	1990	0722	1918
13. Num	2180	2276		1723	2678	0090	2197	2630	1676	2536
14. LSp-Au	1849	1878	1723		1839	1565	1475	2562	1094	1935
15. DsgRp	2151	0654	2678	1839		1035	0868	1638	1527	2825
16. Con-Vb	1806	2321	0090	1565	1035		2307	2044	1649	0711
17. RWd	1131	1658	2197	1475	0868	2307		3755	1045	0995
18. PNum	1617	1990	2630	2562	1638	2044	3755		2071	2304
19. Map-Vb	0454	0722	1676	1094	1527	1649	1045	2071		2093
20. Map-Rc	2669	1918	2536	1935	2825	0711	0995	2304	2093	
21. SenSp	1579	2232	0904	3889	1434	2380	0755	1381	0260	0362
22. PSyl-2	2468	2181	2629	3248	2642	2731	2681	4769	1982	2809
23. RFig	2505	1781	1107	1451	2826	1739	1823	2813	1459	2609
24. Rel	2322	1854	3060	1495	3638	1292	0425	1355	1674	3219
25. SComp	2518	2535	1695	1913	1612	4114	2976	3970	2096	2230
26. InsSp	1332	0105	0328	2185	1729	0736	-0655	0839	0469	0506
27. PWd-R	2464	2566	2482	1800	1265	3398	3593	4608	2243	2229
28. IComp	2018	0641	0671	1737	2781	0619	0015	0742	0727	2272
29. MPrin	0958	1076	-0091	1268	2544	0865	0090	0332	0139	1703
30. RCon	0030	-1019	-0518	0975	-0615	-0302	-0012	-1129	0372	-0585
31. CCoord	1843	0056	0662	1983	1580	0497	0220	1040	0953	1369
32. AReas	1622	2710	1902	2274	2144	2160	1370	1403	0980	1811
33. RdComp	2054	3730	1407	2696	2330	2410	0166	0784	0754	2413
34. Voc	2446	4184	0676	3103	1503	2630	0262	1494	0486	1542
35. DTRd	2159	1762	1742	1950	1790	1154	1396	0946	0987	2124
36. SpaO-1	1475	0978	1460	1332	1931	0503	0460	0771	1161	2032
37. CRd	1569	1598	1268	1148	2521	0603	0893	1150	0844	2562
38. DRTime	2270	1624	1924	1569	1676	1220	1739	1592	0448	1322
39. SpaO-2	1567	1895	1207	1031	3248	0316	0009	0857	1337	3175
40. NumOp	2187	2308	2437	1391	1075	1527	1153	1529	0347	0999

TABLE C-2 (Continued)

Correlations of 40 Tests for 442 Subjects: Matrix R_o

(Decimal points omitted)

		21	22	23	24	25	26	27	28	29	30
1.	Lim	3631	2635	2180	1673	4795	1027	2595	1893	1541	-0956
2.	LSp-Vi	3494	3108	1101	1271	1277	2804	1929	1460	0626	1162
3.	PSyl-1	2255	5091	1300	1453	3216	0793	3082	1059	-0185	-0511
4.	Con-NV	1888	1446	1933	2217	1773	0707	1635	0953	0056	-0702
5.	NSp-Au	3140	2299	0929	1863	1459	2300	1015	1436	1287	1041
6.	PWd-U	1526	3077	2123	1938	3765	-0497	3949	0893	0707	0285
7.	RSyl	1188	2683	2898	1425	2441	-0245	2588	1266	0130	-0366
8.	Ideas	3176	1498	1848	1220	3397	-0334	2049	0495	1510	-0738
9.	Map-Rp	-0402	2917	2690	2578	2325	0708	2689	1696	1100	-0594
10.	NSp-Vi	2790	3317	0470	2040	1570	2912	2295	1047	0529	0257
11.	Pict	1579	2468	2505	2322	2518	1332	2464	2018	0958	0030
12.	Para	2232	2181	1781	1854	2535	0105	2566	0641	1076	-1019
13.	Num	0904	2629	1107	3060	1695	0328	2482	0671	-0091	-0518
14.	LSp-Au	3889	3248	1451	1495	1913	2185	1800	1737	1268	0975
15.	DsgRp	1434	2642	2826	3638	1612	1729	1265	2781	2544	-0615
16.	Con-Vb	2380	2731	1739	1292	4114	0736	3398	0619	0865	-0302
17.	RWd	0755	2681	1823	0425	2976	-0655	3593	0015	0090	-0012
18.	PNum	1381	4769	2813	1355	3970	0839	4608	0742	0332	-1129
19.	Map-Vb	0260	1982	1459	1674	2096	0469	2243	0727	0139	0372
20.	Map-Rc	0362	2809	2609	3219	2230	0506	2229	2272	1703	-0585
21.	SenSp		1976	1527	1069	0720	1402	0884	1338	1745	-0169
22.	PSyl-2	1976		2324	2520	3139	2221	3923	1381	-0003	-0863
23.	RFig	1527	2324		2166	2817	0538	3034	1433	1583	-0549
24.	Rel	1069	2520	2166		1739	0896	1382	2470	1532	-0430
25.	SComp	0720	3139	2817	1739		1091	5199	1306	0493	-0462
26.	InsSp	1402	2221	0538	0896	1091		0430	1202	-0102	-0179
27.	PWd-R	0884	3923	3034	1382	5199	0430		1148	0480	-0316
28.	IComp	1338	1381	1433	2470	1306	1202	1148		3047	1404
29.	MPrin	1745	-0003	1583	1532	0493	-0102	0480	3047		2489
30.	RCon	-0169	-0863	-0549	-0430	-0462	-0179	-0316	1404	2489	
31.	CCoord	-0178	0454	0471	2120	0352	0025	0781	2924	3192	3028
32.	AReas	2676	1689	1594	3602	2159	0767	1731	2922	4516	0326
33.	RdComp	3641	2109	2173	2962	2531	1001	1509	3232	3993	0462
34.	Voc	4462	2917	1957	1823	2494	1345	1809	1996	1666	-0322
35.	DTRd	0991	1779	0830	3731	1536	0745	0908	3533	1780	0517
36.	SpaO-1	1008	1772	0683	1879	0974	1335	1083	2572	1392	0180
37.	CRd	0897	1286	1247	2879	1405	0328	0792	3701	2859	-0061
38.	DRTime	0718	1463	1189	2351	1675	0312	1491	2664	1949	0454
39.	SpaO-2	0975	1514	1581	2696	0890	0507	1185	3465	3154	0146
40.	NumOp	1424	1960	0374	2709	1955	1140	1866	1462	0408	-0866

TABLE C-2 (Continued)

Correlations of 40 Tests for 442 Subjects: Matrix R_o

(Decimal points omitted)

		31	32	33	34	35	36	37	38	39	40
1.	Lim	0981	3347	4592	5927	1345	0530	1008	1224	0847	2503
2.	LSp-Vi	1814	1606	2060	2972	1452	1434	0903	2050	1412	1564
3.	PSyl-1	0203	1279	1424	2584	1475	0892	0365	1178	0407	1469
4.	Con-NV	0764	1772	2038	2516	1712	1947	1350	1688	1659	1834
5.	NSp-Au	2040	1985	1971	2243	1646	0793	1403	2118	0576	1639
6.	PWd-U	0372	1051	1476	1419	-0001	-0445	-0093	1194	-0177	0441
7.	RSyl	0895	1723	2574	2551	1010	-0085	1220	0828	1043	1183
8.	Ideas	1002	1712	2624	3399	0725	0762	0618	0747	0509	1033
9.	Map-Rp	1324	1853	1361	1673	2604	2791	2196	1984	3040	1870
10.	NSp-Vi	1272	2506	1655	2138	1746	1537	1412	1276	1064	2441
11.	Pict	1843	1622	2054	2446	2159	1475	1569	2270	1567	2187
12.	Para	0056	2710	3730	4184	1762	0978	1598	1624	1895	2308
13.	Num	0662	1902	1407	0676	1742	1460	1268	1924	1207	2437
14.	LSp-Au	1983	2274	2696	3103	1950	1332	1148	1569	1031	1391
15.	DsgRp	1580	2144	2330	1503	1790	1931	2521	1676	3248	1075
16.	Con-Vb	0497	2160	2410	2630	1154	0503	0603	1220	0316	1527
17.	RWd	0220	1370	0166	0262	1396	0460	0893	1739	0009	1153
18.	PNum	1040	1403	0784	1494	0946	0771	1150	1592	0857	1529
19.	Map-Vb	0953	0980	0754	0486	0987	1161	0844	0448	1337	0347
20.	Map-Rc	1369	1811	2413	1542	2124	2032	2562	1322	3175	0999
21.	SenSp	-0178	2676	3641	4462	0991	1008	0897	0718	0975	1424
22.	PSyl-2	0454	1689	2109	2917	1779	1772	1286	1463	1514	1960
23.	RFig	0471	1594	2173	1957	0830	0683	1247	1189	1581	0374
24.	Rel	2120	3602	2962	1823	3731	1879	2879	2351	2696	2709
25.	SComp	0352	2159	2531	2494	1536	0974	1405	1675	0890	1955
26.	InsSp	0025	0767	1001	1345	0745	1335	0328	0312	0507	1140
27.	PWd-R	0781	1731	1509	1809	0908	1083	0792	1491	1185	1866
28.	IComp	2924	2922	3232	1996	3533	2572	3701	2664	3465	1462
29.	MPrin	3192	4516	3993	1666	1780	1392	2859	1949	3154	0408
30.	RCon	3028	0326	0462	-0322	0517	0180	-0061	0454	0146	-0866
31.	CCoord		1924	1843	0968	2744	2373	2262	3350	2892	1537
32.	AReas	1924		5445	3463	3812	0486	3588	2276	3140	4776
33.	RdComp	1843	5445		6109	2792	1476	2339	2058	3073	2343
34.	Voc	0968	3463	6109		2114	1850	1647	2104	2054	2672
35.	DTRd	2744	3812	2792	2114		4448	5725	3619	3291	5196
36.	SpaO-1	2373	0486	1476	1850	4448		3853	3228	4247	2051
37.	CRu	2262	3588	2339	1647	5725	3853		2761	3812	3911
38.	DRTime	3350	2276	2058	2104	3619	3228	2761		2277	2901
39.	SpaO-2	2892	3140	3073	2054	3291	4247	3812	2277		1543
40.	NumOp	1537	4776	2343	2672	5196	2051	3911	2901	1543	

TABLE C-3

Weight Matrix W_a

(All empty cells contain zero weights)

Test	A_1	B_1	C_1	D_1	E_1	F_1	G_1
1. Lim	1						
2. LSp-Vi						1	
3. PSyl-1							1
4. Con-NV							
5. NSp-Au						1	
6. PWd-U							1
7. RSyl							
8. Ideas							
9. Map-Rp							
10. NSp-Vi						1	
11. Pict							
12. Para	1						
13. Num							
14. LSp-Au						1	
15. DsgRp							
16. Con-Vb							
17. RWd							
18. PNum							1
19. Map-Vb							
20. Map-Rc							
21. SenSp						1	
22. PSyl-2							1
23. RFig							
24. Rel				1			
25. SComp							1
26. InsSp							
27. PWd-R							1
28. IComp			1	1	1		
29. MPrin				1	1		
30. RCon					1		
31. CCoord					1		
32. AReas		1		1			
33. RdComp	1			1			
34. Voc	1						
35. DTRd		1	1				
36. SpaO-1			1				
37. CRd			1	1			
38. DRTime							
39. SpaO-2			1	1			
40. NumOp		1					

TABLE C-4

Factor Matrix F_a

(Decimal points omitted)

Test	A_1	B_1	C_1	D_1	E_1	F_1	G_1
1. Lim	70	-06	-09	-06	09	01	10
2. LSp-Vi	33	04	08	-10	25	59	00
3. PSyl-1	29	04	-02	-17	04	23	50
4. Con-NV	33	09	08	-12	-10	05	05
5. NSp-Au	24	14	-00	06	21	65	-01
6. PWd-U	27	-10	-06	10	06	19	55
7. RSyl	36	-02	01	-00	-03	01	24
8. Ideas	48	-13	-02	-07	09	04	08
9. Map-Rp	22	21	25	-04	-13	02	30
10. NSp-Vi	27	20	-04	-06	07	62	07
11. Pict	31	13	10	-05	11	10	16
12. Para	55	02	-02	-08	-16	-00	08
13. Num	16	24	-03	01	-17	18	27
14. LSp-Au	38	07	05	-05	26	62	05
15. DsgRp	20	15	32	35	-28	23	14
16. Con-Vb	41	00	-10	-07	07	01	26
17. RWd	11	15	-09	-13	07	11	46
18. PNum	23	07	01	-07	-02	20	63
19. Map-Vb	11	06	12	02	-04	14	22
20. Map-Rc	27	10	32	17	-25	16	22
21. SenSp	50	-05	-01	01	-02	34	-12
22. PSyl-2	35	07	09	-12	-12	29	46
23. RFig	29	-04	14	17	-17	07	28
24. Rel	30	38	10	12	-12	08	12
25. SComp	44	03	00	-12	-00	-03	49
26. InsSp	12	07	05	-07	-01	32	-03
27. PWd-R	30	05	01	-08	04	07	59
28. IComp	28	27	39	20	09	01	05
29. MPrin	30	19	23	51	16	-04	-05
30. RCon	-07	04	10	22	55	01	-03
31. CCord	14	26	29	19	38	02	02
32. AReas	54	44	-10	37	-03	03	-01
33. RdComp	74	11	07	25	03	-04	-09
34. Voc	80	-07	05	-11	04	03	-10
35. DTRd	29	65	27	-12	03	-01	-01
36. SpaO-1	17	29	56	-23	02	04	-01
37. CRd	24	60	36	-03	-06	-02	-02
38. DRTime	25	34	21	-08	25	-01	09
39. SpaO-2	28	27	48	17	-08	-01	-01
40. NumOp	35	64	-17	-25	-00	-01	02

TABLE G-5

Residual Correlation Matrix R_a

(Decimal points omitted)

Test	1	2	3	4	5	6	7	8	9	10
1. Lin		-0211	-0266	0660	-0195	-0343	-0473	1607	-0279	0248
2. LSp-Vi	-0211		-0322	0398	-0291	-0260	0079	-0594	0586	0352
3. PSyl-1	-0266	-0322		-0668	-0109	0156	-0163	-0576	-0349	0000
4. Con-NV	0660	0398	-0668		-0094	0884	-0592	1082	0870	0225
5. NSp-Au	-0195	-0291	-0109	-0094		0073	-0025	0203	0114	-0090
6. PWd-U	-0343	-0260	0156	0884	0073		0015	0575	0165	-0201
7. RSyl	-0473	0079	-0163	-0592	-0025	0015		-0983	-0113	-0058
8. Ideas	1607	-0594	-0576	1082	0203	0575	-0983		0796	0239
9. Map-Rp	-0279	0586	-0349	0870	0114	0165	-0113	0796		0301
10. NSp-Vi	0248	0352	0000	0225	-0090	-0201	-0058	0239	0301	
11. Pict	-0085	0321	-0340	0496	0152	-0017	0343	0470	0494	0075
12. Para	-0686	0323	-0378	-0402	-0027	0672	0399	-0448	0313	-0031
13. Num	-1011	-0085	-0069	0201	0101	0143	0573	-0129	0603	-0087
14. LSp-Au	-0028	-0166	-0211	-0725	0269	0262	0363	-0529	0121	0066
15. DsgRp	0457	0305	0265	0483	-0127	-0869	-0010	0362	0709	-0210
16. Con-Vb	0642	-0107	-0659	0278	-0047	-0516	-0403	0787	-0259	-0146
17. RWd	-0370	-0402	-1665	-0250	-0134	1371	0192	0834	0357	0198
18. PNum	-0127	0144	-0188	0051	-0132	0326	0069	-0301	0281	-0474
19. Map-Vb	0282	-0114	-0364	0361	0170	-0865	0723	0498	0561	0695
20. Map-Re	0163	0960	-0227	0056	0066	-0004	0624	0462	0479	-0082
21. SenSp	0186	-0042	0641	0196	-0183	0125	-0360	0681	-1123	-0469
22. PSyl-2	-0190	0288	0903	-0454	-0220	-0666	0262	-0567	0085	0120
23. RFig	0215	0209	-0708	0760	0074	-0370	1109	0430	0764	-0612
24. Rel	-0039	0029	-0092	0757	0326	0697	0074	0339	0365	0120
25. SComp	1125	-0123	-0667	-0C48	0669	0084	-0301	0820	-0262	0120
26. InsSp	0215	0384	-0296	-0034	-0144	-1105	-0641	-0974	0131	0429
27. PWd-R	-0199	0273	-1094	0235	-0281	-0142	0117	0048	0080	0435
28. IComp	0463	0017	0247	-0208	-0005	0081	0179	-0435	-0388	-0166
29. MPrin	0013	-0258	0033	-0461	-0075	-0077	-0767	0604	0061	-0096
30. RCon	-0687	0095	-0034	0228	-0209	0159	0114	-0660	0097	0093
31. CCoord	0211	0146	-0246	0441	0289	-0162	0474	0491	0230	0169
32. AReas	0015	-0001	0088	0119	-0293	-0417	-0105	-0063	0092	0179
33. RdComp	-0235	-0057	0166	-0122	0052	-0109	0166	-0561	-0246	-0114
34. Voc	0292	-0054	0478	-0137	0170	-0219	-0092	-0598	0212	-0103
35. DTRd	-0104	-0092	0273	-0106	0154	0207	0088	0124	-0078	-0241
36. SpaO-1	-0143	-0195	-0078	0400	-0144	-0112	-0720	0195	0350	0331
37. CRd	0108	-0174	-0405	-0307	0288	0262	0447	0354	-0527	-0127
38. DRTime	-0496	0243	-0337	0528	0608	0416	-0177	-0349	0188	-0255
39. SpaO-2	-0326	0444	-0037	0222	-0293	-0437	0006	-0238	0643	0203
40. NumOp	0088	0093	-0360	-0012	0139	0210	0016	-0061	-0014	0062

TABLE C-5 (Continued)

Residual Correlation Matrix R_a

(Decimal points omitted)

Test	11	12	13	14	15	16	17	18	19	20
1. Lin	-0085	-0686	-1011	-0028	0457	0642	-0370	-0127	0282	0163
2. LSp-Vi	0321	0323	-0085	-0166	0305	-0107	-0402	0144	-0114	0960
3. PSyl-1	-0340	-0378	-0069	-0211	0265	-0659	-1665	-0188	-0364	-0227
4. Con-NV	0496	-0402	0201	-0725	0483	0278	-0250	0051	0361	0056
5. NSp-Au	0152	-0027	0101	0269	-0127	-0047	-0134	-0132	0170	0066
6. PWd-U	-0017	0672	0143	0262	-0869	-0516	1371	0326	-0865	-0004
7. RSyl	0343	0399	0573	0363	-0010	-0403	0192	0069	0723	0624
8. Ideas	0470	-0448	-0129	-0529	0362	0787	0834	-0301	0498	0462
9. Map-Rp	0494	0313	0603	0121	0709	-0259	0357	0281	0561	0479
10. NSp-Vi	0075	-0031	-0087	0066	-0210	-0146	0198	-0474	0695	-0082
11. Pict		0237	0961	-0506	0998	0101	-0327	-0439	-0537	1204
12. Para	0237		0869	0144	-0709	-0080	0626	0111	-0084	0057
13. Num	0961	0869		0169	0818	-1179	0343	0039	0502	0656
14. LSp-Au	-0506	0144	0169		0200	-0332	-0133	0113	-0285	0300
15. DegRp	0998	-0709	0818	0200		0589	0456	-0098	0024	-0896
16. Con-Vb	0101	-0080	-1179	-0332	0589		0442	-0540	0790	-0332
17. RWd	-0327	0626	0343	-0133	0456	0442		0226	-0160	0041
18. PNum	-0439	0111	0039	0113	-0098	-0540	0226		0124	-0041
19. Map-Vb	-0537	-0084	0502	-0285	0024	0790	-0160	0124		0510
20. Map-Rc	1204	0057	0656	0300	-0896	-0332	0041	-0041	0510	
21. SenSp	-0042	-0408	-0096	0043	-0169	0633	0472	0349	-0466	-1244
22. PSyl-2	0199	-0404	-0024	0009	0305	0166	-0262	0293	0012	-0073
23. RFig	1243	-0141	-0404	0217	0223	0223	0652	0342	0177	-0038
24. Rel	0706	-0034	1030	-0094	1042	0024	-0781	-0447	0560	0799
25. SComp	0286	-0407	-0326	0116	0460	0981	0072	-0175	0590	0187
26. InsSp	0493	-0615	-0520	-0353	0704	0289	-1131	0003	-0142	-0443
27. PWd-R	0311	0406	0237	-0290	-0063	0567	0257	-0041	0504	0158
28. IComp	0302	-0595	-0317	0057	0033	-0183	-0392	-0263	-0332	-0245
29. MPrin	-0270	0142	-0543	0005	-0219	0253	0487	0280	-0473	-0329
30. RCon	-0402	0417	0460	-0182	-0087	-0092	0121	-0571	0495	0261
31. CCoord	0370	0036	0400	0121	0273	0022	-0216	0554	0310	0314
32. AReas	-0356	-0090	-0192	0062	-0697	0167	0515	0117	0123	-0496
33. RdComp	-0186	0009	0300	0104	-0121	-0131	-0012	-0167	-0001	0015
34. Voc	0034	-0122	-0158	-0220	0374	-0430	-0244	0184	-0197	-0234
35. DTRd	0064	0081	-0094	0258	-0114	0146	0213	-0162	0047	0130
36. SpeO-1	-0169	-0055	0689	-0182	0120	0167	-0004	-0055	0162	-0142
37. CRd	-0234	0166	-0445	-0051	-0002	0033	0139	0293	-0141	0131
38. DRTime	0363	0484	0965	-0399	0818	-0069	0453	0208	-0363	0179
39. SpeO-2	0037	0403	0167	-0082	-0038	-0163	0044	0187	0265	0126
40. NumOp	0292	0009	0285	-0319	0811	-0313	-0728	0045	-0170	0366

TABLE C-5 (Continued)

Residual Correlation Matrix R_e

(Decimal points omitted)

Test	21	22	23	24	25	26	27	28	29	30
1. Lim	0186	-0190	0215	-0039	1125	0215	-0199	0463	0013	-0687
2. LSp-Vi	-0042	0288	0209	0029	-0123	0384	0273	0017	-0258	0095
3. PSyl-1	0641	0903	-0708	-0092	-0667	-0296	-1094	0247	0033	-0034
4. Con-NV	0196	-0454	0760	0757	-0048	-0034	0235	-0208	-0461	0228
5. NSp-Au	-0183	-0220	0074	0326	0669	-0144	-0281	-0005	-0075	-0209
6. PWd-U	0125	-0666	-0370	0697	0084	-1105	-0142	0081	-0077	0159
7. RSyl	-0360	0262	1109	0074	-0301	-0641	0117	0179	-0767	0114
8. Ideas	0681	-0567	0430	0339	0820	-0974	0048	-0435	0604	-0660
9. Map-Rp	-1123	0085	0764	0365	-0262	0131	0080	-0388	0061	0097
10. NSp-Vi	-0469	0120	-0612	0120	0120	0429	0435	-0166	-0096	0093
11. Pict	-0042	0199	1243	0706	0286	0493	0311	0302	-0270	-0402
12. Para	-0408	-0404	-0141	-0034	-0407	-0615	0406	-0595	0142	0417
13. Num	-0096	-0024	-0404	1030	-0326	-0520	0237	-0317	-0543	0460
14. LSp-Au	0043	0009	0217	-0094	0116	-0353	-0290	0057	0005	-0182
15. DagRp	-0169	0305	0223	1042	0460	0704	-0063	0033	-0219	-0087
16. Con-Vb	0633	0166	0223	0024	0981	0289	0567	-0183	0253	-0092
17. RWd	0472	-0262	0652	-0781	0072	-1131	0257	-0392	0487	0121
18. PNum	0349	0293	0342	-0447	-0175	0003	-0041	-0263	0280	-0571
19. Map-Vb	-0466	0012	0177	0560	0590	-0142	0504	-0332	-0473	0495
20. Map-Rc	-1244	-0073	-0038	0799	0187	-0443	0158	-0245	-0329	0261
21. SenSp		-0197	0112	-0381	-0782	-0316	-0136	0098	0425	0203
22. PSyl-2	-0197		-0301	0317	-0768	0780	-0192	-0039	-0259	0269
23. RFig	0112	-0301		0488	0384	0071	0654	-0149	0032	0134
24. Rel	-0381	0317	0488		-0113	0072	-0362	0047	-0599	-0059
25. SComp	-0782	-0768	0384	-0113		0702	0862	0019	-0057	0235
26. InsSp	-0316	0780	0071	0072	0702		-0083	0581	-0233	0014
27. PWd-R	-0136	-0192	0654	-0362	0862	-0083		-0045	0079	-0058
28. IComp	0098	-0039	-0149	0047	0019	0581	-0045		-0297	0132
29. MPrin	0425	-0259	0032	-0599	-0057	-0233	0079	-0297		0343
30. RCon	0203	0269	0134	-0059	0235	0014	-0058	0132	0343	
31. CCoord	-0725	0029	-0016	0610	-0198	-0363	0023	-0042	0055	0194
32. AReas	0053	-0100	-0343	-0056	0136	0008	0176	-0100	0512	-0089
33. RdComp	0016	0227	-0122	0159	-0046	0247	-0071	0134	0056	0060
34. Voc	0207	0367	0047	-0086	-0673	0152	-0136	-0001	-0211	0210
35. DTRd	-0078	0042	0140	0334	0008	-0240	-0368	0162	-0364	0243
36. SpaO-1	0190	0143	-0085	-0006	-0087	0334	0190	-0378	0232	0012
37. CRd	0063	-0245	0293	-0455	0250	-0531	-0156	0169	0434	-0178
38. DRTime	-0198	-0057	0581	0408	-0057	-0321	-0174	0124	0120	-0921
39. SpaO-2	-0273	0099	-0200	0079	-0190	-0144	0378	-0160	-0005	-0210
40. NumOp	0025	0057	0202	-0278	-0144	0233	0192	-0062	-0147	-0154

TABLE C-5 (Continued)

Residual Correlation Matrix R$_a$

(Decimal points omitted)

Test	31	32	33	34	35	36	37	38	39	40
1. Lim	0211	0015	-0235	0292	-0104	-0143	0108	-0496	-0326	0088
2. LSp-Vi	0146	-0001	-0057	-0054	-0092	-0195	-0174	0243	0444	0093
3. PSyl-1	-0246	0086	0166	0478	0273	-0078	-0405	-0337	-0037	-0360
4. Con-NV	0441	0119	-0122	-0137	-0106	0400	-0307	0528	0222	-0012
5. NSp-Au	0289	-0293	0052	0170	0154	-0144	0288	0608	-0293	0139
6. PWd-U	-0162	-0417	-0109	-0219	0207	-0112	0262	0416	-0437	0210
7. RSyl	0474	-0105	0166	-0092	0088	-0720	0447	-0177	0006	0016
8. Ideas	0491	-0063	-0561	-0598	0124	0195	0354	-0349	-0238	-0061
9. Map-Rp	0230	0092	-0246	0212	-0078	0350	-0527	0188	0643	-0014
10. NSp-Vi	0169	0179	-0114	-0103	-0241	0331	-0127	-0255	0203	0062
11. Pict	0370	-0356	-0186	0034	0064	-0169	-0234	0363	0037	0292
12. Para	0036	-0090	0009	-0122	0081	-0055	0166	0484	0403	0009
13. Num	0400	-0192	0300	-0158	-0094	0689	-0445	0965	0167	0285
14. LSp-Au	0121	0062	0104	-0220	0258	-0182	-0051	-0399	-0082	-0319
15. DsgRp	0273	-0697	-0121	0374	-0114	0120	-0002	0818	-0038	0811
16. Con-Vb	0022	0167	-0131	-0430	0146	0167	0033	-0069	-0163	-0313
17. RWd	-0216	0515	-0012	-0244	0213	-0004	0139	0453	0044	-0728
18. PNum	0554	0117	-0167	0184	-0162	-0055	0293	0208	0187	0045
19. Map-Vb	0310	0123	-0001	-0197	0047	0162	-0141	-0363	0265	-0170
20. Map-Rc	0314	-0496	0015	-0234	0130	-0142	0131	0179	0126	0366
21. SenSp	-0725	0053	0016	0207	-0078	0190	0063	-0198	-0273	0025
22. PSyl-2	0029	-0100	0227	0367	0042	0143	-0245	-0057	0099	0057
23. RFig	-0016	-0343	-0122	0047	0140	-0085	0293	0581	-0200	0202
24. Rel	0610	-0056	0159	-0086	0334	-0006	-0455	0408	0079	-0278
25. SComp	-0198	0136	-0046	-0673	0008	-0087	0250	-0057	-0190	-0144
26. InsSp	-0363	0008	0247	0152	-0240	0334	-0531	-0321	-0144	0233
27. PWd-R	0023	0176	-0071	-0136	-0368	0190	-0156	-0174	0378	0192
28. IComp	-0042	-0100	0134	-0001	0162	-0378	0169	0124	-0160	-0062
29. MPrin	0055	0512	0056	-0211	-0364	0232	0424	0120	-0005	-0147
30. RCon	0194	-0089	0060	0210	0243	0012	-0178	-0921	-0210	-0154
31. CCoord		-0322	-0249	0002	-0041	0135	-0426	0677	0375	0363
32. AReas	-0322		0152	-0077	0060	-0325	0081	-0007	0285	0815
33. RdComp	-0249	0152		0453	0043	0097	-0243	-0120	-0032	-0196
34. Voc	0002	-0077	0453		-0021	0100	-0031	0132	-0046	0099
35. DTRd	-0041	0060	0043	-0021		0322	0128	-0031	-0363	0189
36. SpaO-1	0135	-0325	0097	0100	0322		-0310	0432	0690	0004
37. CRd	-0426	0081	-0243	-0031	0128	-0310		-0492	-0207	-0209
38. DRTime	0677	-0007	-0120	0132	-0031	0432	-0492		-0033	0039
39. SpaO-2	0375	0285	-0032	-0046	-0363	0690	-0207	-0033		0078
40. NumOp	0363	0815	-0196	0099	0189	0004	-0209	0039	0078	

Weight Matrix W_b

(All empty cells contain zero weights)

Test	H_1	I_1	J_1	K_1
1. Lim	1			
2. LSp-Vi			-1	
3. PSyl-1		-1		
4. Con-NV	1			
5. NSp-Au				
6. PWd-U			1	
7. RSyl	-1			
8. Ideas	1	1	1	
9. Map-Rp				1
10. NSp-Vi				
11. Pict				1
12. Para	-1			
13. Num				1
14. LSp-Au				
15. DsgRp	1			
16. Con-Vb	1	1		
17. RWd		1	1	
18. PNum				
19. Map-Vb				
20. Map-Rc				1
21. SenSp			1	-1
22. PSyl-2			-1	
23. RFig		1		
24. Rel				1
25. SComp	1	1		
26. InsSp			-1	
27. PWd-R		1		
28. IComp				
29. MPrin				
30. RCon				
31. CCoord				1
32. AReas				
33. RdComp				
34. Voc		-1		
35. DTRd				
36. SpaO-1				
37. CRd				
38. DRTime				1
39. SpaO-2				
40. NumOp				

TABLE C-7

Factor Matrix F_b

(Decimal points omitted)

Test		H_1	I_1	J_1	K_1
1.	Lim	35	-06	01	-08
2.	LSp-Vi	-04	00	-17	07
3.	PSyl-1	-10	-37	09	-05
4.	Con-NV	22	02	06	17
5.	NSp-Au	02	01	03	10
6.	PWd-U	-04	09	31	12
7.	RSyl	-21	14	-06	08
8.	Ideas	38	08	23	11
9.	Map-Rp	07	05	-08	21
10.	NSp-Vi	03	00	-08	02
11.	Pict	08	09	-12	24
12.	Para	-20	16	05	11
13.	Num	-15	03	08	32
14.	LSp-Au	-09	03	02	-02
15.	DsgRp	20	-05	-12	18
16.	Con-Vb	24	15	-07	-16
17.	RWd	02	33	23	-02
18.	PNum	-07	02	02	-01
19.	Map-Vb	09	11	-12	06
20.	Map-Rc	05	09	-10	28
21.	SenSp	07	-04	19	-21
22.	PSyl-2	-07	-14	-15	02
23.	RFig	06	21	-06	09
24.	Rel	10	-08	-02	28
25.	SComp	25	16	-11	-03
26.	InsSp	11	-13	-33	-09
27.	PWd-R	05	25	-12	-04
28.	IComp	01	-09	-04	-03
29.	MPrin	04	07	10	-09
30.	RCon	-08	02	-02	-04
31.	CCoord	04	-00	-03	20
32.	AReas	-01	04	-00	-08
33.	RdComp	-07	-05	-03	-02
34.	Voc	-05	-16	00	00
35.	DTRd	-01	01	05	03
36.	SpaO-1	07	-03	-01	06
37.	CRd	-01	08	07	-12
38.	DRTime	00	03	01	20
39.	SpaO-2	-06	02	-08	07
40.	NumOp	02	-05	-04	05

TABLE C-8

Residual Correlation Matrix $R_b = R_1$

(Decimal points omitted)

Test	1	2	3	4	5	6	7	8	9	10
1. Lim		0000	-0196	0018	-0193	-0085	0422	0386	-0307	0176
2. LSp-Vi	0000		-0157	0448	-0309	0175	-0164	-0151	0314	0212
3. PSyl-1	-0196	-0157		-0339	-0025	0237	0244	-0037	0080	0111
4. Con-NV	0018	0448	-0339		-0333	0578	-0262	-0088	0392	0177
5. NSp-Au	-0193	-0309	-0025	-0333		-0130	-0055	-0064	-0096	-0092
6. PWd-U	-0085	0175	0237	0578	-0130		-0107	-0177	0140	0032
7. RSyl	0422	-0164	0244	-0262	-0055	-0107		-0269	-0260	-0064
8. Ideas	0386	-0151	-0037	-0088	-0064	-0177	-0269		0440	0292
9. Map-Rp	-0307	0314	0080	0392	-0096	0140	-0260	0440		0183
10. NSp-Vi	0176	0212	0111	0177	-0092	0032	-0064	0292	0183	
11. Pict	-0119	-0035	0285	-0045	-0080	0026	0133	0090	-0202	-0084
12. Para	0186	0251	0031	-0228	-0127	0153	-0288	-0089	0161	0039
13. Num	-0220	-0236	-0026	-0070	-0210	-0579	0014	-0134	0076	-0040
14. LSp-Au	0286	-0153	-0217	-0521	0296	0156	0165	-0249	0215	0108
15. DsgRp	-0127	0028	0466	-0187	-0311	-0562	0262	-0268	0124	-0394
16. Con-Vb	-0236	-0027	0117	0023	0059	-0151	-0021	0088	-0218	-0240
17. RWd	-0278	0007	-0623	-0452	-0214	0397	-0075	0000	0401	0370
18. PNum	0112	0160	-0215	0196	-0117	0228	-0075	-0101	0348	-0439
19. Map-Vb	0086	-0341	0284	0099	0112	-0621	0640	0264	0220	0562
20. Map-Rc	0634	0554	0286	-0274	-0183	-0124	0107	0494	-0205	-0199
21. SenSp	-0295	0476	0283	0294	-0039	-0150	0137	0242	-0555	-0301
22. PSyl-2	-0006	0000	0441	-0227	-0170	-0135	0218	0110	0046	0022
23. RFig	0202	0058	0228	0462	-0033	-0457	0843	0057	0385	-0693
24. Rel	-0202	-0185	-0127	0094	0041	0553	0143	-0216	-0271	0025
25. SComp	0318	-0211	0264	-0516	0661	0442	-0038	0036	-0531	-0036
26. InsSp	-0266	-0082	-0424	0111	0031	0197	-0368	-0406	0065	0158
27. PWd-R	-0223	0099	-0038	0222	-0242	0078	-0172	-0007	-0086	0330
28. IComp	0373	-0022	-0057	-0130	0042	0311	0312	-0266	-0314	-0190
29. MPrin	-0158	-0016	0195	-0464	-0031	-0319	-0657	0288	0259	-0017
30. RCon	-0424	0052	-0022	0474	-0150	0226	-0064	-0288	0198	0102
31. CCoord	0248	-0051	-0092	0037	0091	-0275	0370	0212	-0245	0096
32. AReas	-0000	0046	0189	0260	-0217	-0349	-0111	0026	0238	0191
33. RdComp	-0033	-0117	-0058	0085	0097	0014	0086	-0183	-0161	-0114
34. Voc	0366	-0069	-0150	-0011	0191	-0106	0023	-0300	0312	-0088
35. DTRd	-0045	-0037	0264	-0160	0114	0018	0061	0021	-0099	-0207
36. SpaO-1	-0358	-0226	-0070	0156	-0212	-0105	-0590	-0093	0188	0296
37. CRd	0083	0741	-0222	-0137	0384	0098	0455	0287	-0245	-0045
38. DRTime	-0329	0115	-0123	0160	0399	0109	-0370	-0644	-0249	-0282
39. SpaO-2	-0053	0243	0085	0271	-0327	-0322	-0238	0052	0471	0147
40. NumOp	0045	-0009	-0454	-0100	0103	0331	0050	-0046	-0139	0016

TABLE C-8 (Continued)

Residual Correlation Matrix $R_b \equiv R_1$

(Decimal points omitted)

Test	11	12	13	14	15	16	17	18	19	20
1. Lin	-0119	0186	-0220	0286	-0127	-0236	-0278	0112	0086	0634
2. LSp-Vi	-0035	0251	-0236	-0153	0028	-0027	0007	0160	-0341	0554
3. PSyl-1	0285	0031	-0026	-0217	0466	0117	-0623	-0215	0284	0286
4. Con-NV	-0045	-0228	-0070	-0521	-0187	0023	-0452	0196	0099	-0274
5. NSp-Au	-0080	-0127	-0210	0296	-0311	0059	-0214	-0117	0112	-0183
6. PWd-U	0026	0153	-0579	0156	-0562	-0151	0397	0228	-0621	-0124
7. RSyl	0133	-0288	0014	0165	0262	-0021	-0075	-0075	0640	0107
8. Ideas	0090	-0089	-0134	-0249	-0268	0088	0000	-0101	0264	0494
9. Map-Rp	-0202	0161	0076	0215	0124	-0218	0401	0348	0220	-0205
10. NSp-Vi	-0084	0039	-0040	0108	-0394	-0240	0370	-0439	0562	-0199
11. Pict		0049	0396	-0398	0305	0066	-0307	-0357	-0997	0382
12. Para	0049		0124	-0065	-0378	0371	0049	-0047	-0086	-0453
13. Num	0396	0124		0062	0662	-0306	0155	-0060	0517	-0258
14. LSp-Au	-0398	-0065	0062		0444	-0173	-0259	0045	-0201	0294
15. DsgRp	0305	-0378	0662	0444		0376	0912	0083	-0363	-1375
16. Con-Vb	0066	0371	-0306	-0173	0376		0035	-0400	0411	0025
17. RWd	-0307	0049	0155	-0259	0912	0035		0137	-0256	0041
18. PNm	-0357	-0047	-0060	0045	0083	-0400	0137		0196	-0049
19. Map-Vb	-0997	-0086	0517	-0201	-0363	0411	-0256	0196		0165
20. Map-Rc	0382	-0453	-0258	0294	-1375	0025	0041	-0049	0165	
21. SenSp	0662	-0053	0543	0049	0276	0320	0120	0352	-0128	-0385
22. PSyl-2	0158	-0258	-0025	0023	0148	0468	0555	0302	0044	-0181
23. RFig	0735	-0420	-0606	0238	-0023	-0135	0104	0367	-0237	-0500
24. Rel	0000	-0033	0325	0061	0280	0324	-0433	-0346	0359	0111
25. SComp	-0115	-0068	0205	0311	-0047	0009	-0243	-0011	0059	0149
26. InsSp	0348	0068	0246	-0173	0182	-0149	0007	0155	-0444	-0347
27. PWd-R	0012	0213	0460	-0302	-0106	-0050	-0294	-0029	0062	-0054
28. IComp	0398	-0396	-0161	0089	-0017	-0137	-0027	-0240	-0267	-0120
29. MPrin	-0040	0158	-0311	-0014	0015	-0004	0023	0268	-0415	-0033
30. RCon	-0297	0285	0478	-0258	0118	-0014	0107	-0625	0535	0281
31. CCoord	-0176	-0102	-0159	0191	-0203	0230	-0094	0599	0117	-0263
32. AReas	-0204	-0071	0039	0034	-0532	0003	0385	0102	0128	-0321
33. RdComp	-0081	-0016	0292	0060	-0012	0053	0214	-0201	0090	0043
34. Voc	0196	0025	-0199	-0216	0379	-0080	0277	0178	0018	-0131
35. DTRd	0053	-0007	-0240	0241	-0082	0236	0090	-0178	0087	0085
36. SpaO-1	-0351	0059	0621	-0103	-0146	0122	0097	0001	0082	-0253
37. CRd	0081	0119	-0150	-0116	0372	-0212	-0332	0250	-0064	0470
38. DRTime	-0133	0201	0306	-0376	0483	0198	0357	0217	-0509	-0401
39. SpaO-2	-0181	0225	-0070	-0111	-0127	-0008	0171	0166	0162	-0182
40. NumOp	0151	0079	0201	-0276	0614	-0238	-0475	0076	-0215	0236

TABLE C-8 (Continued)

Residual Correlation Matrix $R_b = R_1$

(Decimal points omitted)

Test	21	22	23	24	25	26	27	28	29	30
1. Lin	-0295	-0006	0202	-0202	0318	-0266	-0223	0373	-0158	-0424
2. LSp-Vi	0476	0000	0058	-0185	-0211	-0082	0099	-0022	-0016	0052
3. PSyl-1	0283	0441	0228	-0127	0264	-0424	-0038	-0057	0195	-0022
4. Con-NV	0294	-0227	0462	0094	-0516	0111	0222	-0130	-0464	0474
5. NSp-Au	-0039	-0170	-0033	0041	0661	0031	-0242	0042	-0031	-0150
6. PWd-U	-0150	-0135	-0457	0553	0442	0197	0078	0311	-0319	0226
7. RSyl	0137	0218	0843	0143	-0038	-0368	-0172	0312	-0657	-0064
8. Ideas	0242	0110	0057	-0216	0036	-0406	-0007	-0266	0288	-0288
9. Map-Rp	-0555	0046	0385	-0271	-0531	0065	-0086	-0314	0259	0198
10. NSp-Vi	-0301	0022	-0693	0025	-0036	0158	0330	-0190	-0017	0102
11. Pict	0662	0158	0735	0000	-0115	0348	0012	0398	-0040	-0297
12. Para	-0053	-0258	-0420	-0033	-0068	0068	0213	-0396	0158	0285
13. Num	0543	-0025	-0606	0325	0205	0246	0460	-0161	-0311	0478
14. LSp-Au	0049	0023	0238	0061	0311	-0173	-0302	0089	-0014	-0258
15. DsgRp	0276	0148	-0023	0280	-0047	0182	-0106	-0017	0015	0118
16. Con-Vb	0320	0468	-0135	0324	0009	-0149	-0050	-0137	-0004	-0014
17. RWd	0120	0555	0104	-0433	-0243	0007	-0294	-0027	0023	0107
18. FNum	0352	0302	0367	-0346	-0011	0155	-0029	-0240	0268	-0625
19. Map-Vb	-0128	0044	-0237	0359	0059	-0444	0062	-0267	-0415	0535
20. Map-Rc	-0385	-0181	-0500	0111	0149	-0347	-0054	-0120	-0033	0281
21. SenSp		0111	0452	0148	-0752	-0012	0085	0066	0062	0237
22. PSyl-2	0111		-0065	0182	-0534	0202	0020	-0208	0018	0222
23. RFig	0452	-0065		0329	-0140	0163	0077	0034	0000	0153
24. Rel	0148	0182	0329		-0169	0055	-0135	0047	-0320	0133
25. SComp	-0752	-0534	-0140	-0169		0228	0204	0093	-0176	0354
26. InsSp	-0012	0202	0163	0055	0228		-0257	0314	0052	0008
27. PWd-R	0085	0020	0077	-0135	0204	-0257		0112	-0020	-0124
28. IComp	0066	-0208	0034	0047	0093	0314	0112		-0230	0136
29. MPrin	0062	0018	0000	-0320	-0176	0052	-0020	-0230		0348
30. RCon	0237	0222	0153	0133	0354	0008	-0124	0136	0348	
31. CCoord	-0264	-0041	-0230	0006	-0256	-0329	0051	-0001	0249	0290
32. AReas	-0081	-0041	-0352	0195	0061	-0025	0049	-0091	0426	-0133
33. RdComp	0063	0078	0016	0232	0160	0147	0032	0081	0124	0004
34. Voc	0184	0114	0396	-0174	-0305	0010	0271	-0133	-0085	0212
35. DTRd	-0095	0108	0132	0282	0085	-0039	-0314	0195	-0385	0255
36. SpaO-1	0263	0131	-0130	-0255	-0212	0258	0235	-0390	0280	0092
37. CRd	-0295	0001	0274	-0021	0182	-0284	-0319	0235	0204	-0232
38. DRTime	0214	-0028	0340	-0129	-0036	-0051	-0162	0216	0258	-0847
39. SpaO-2	0061	-0032	-0310	-0053	-0148	-0249	0286	-0148	0131	-0252
40. NumOp	0177	-0067	0219	-0476	-0146	0063	0265	-0104	-0041	-0122

TABLE C-8 (Continued)

Residual Correlation Matrix $R_b \equiv R_1$

(Decimal points omitted)

Test	31	32	33	34	35	36	37	38	39	40
1. Lim	0248	-0000	-0033	0366	-0045	-0358	0083	-0329	-0053	0045
2. LSp-Vi	-0051	0046	-0117	-0069	-0037	-0226	0041	0115	0243	-0009
3. PSyl-1	-0092	0189	-0058	-0150	0264	-0070	-0222	-0123	0085	-0454
4. Con-NV	0037	0260	0085	-0011	-0160	0156	-0137	0160	0271	-0100
5. NSp-Au	0091	-0217	0097	0191	0114	-0212	0384	0399	-0327	0103
6. PWd-U	-0275	-0349	0014	-0106	0018	-0105	0098	0109	-0322	0331
7. RSyl	0370	-0111	0086	0023	0061	-0590	0455	-0370	-0238	0050
8. Ideas	0212	0026	-0183	-0300	0021	-0093	0287	-0644	0052	-0046
9. Map-Rp	-0245	0238	-0161	0312	-0099	0188	-0245	-0249	0471	-0139
10. NSp-Vi	0096	0191	-0114	-0088	-0207	C296	-0045	-0282	0147	0016
11. Pict	-0176	-0204	-0081	0196	0053	-0351	0081	-0133	-0181	0151
12. Para	-0102	-0071	-0016	0025	-0007	0059	0119	0201	0225	0079
13. Num	-0159	0039	0292	-0199	-0240	0621	-0150	0306	-0070	0201
14. LSp-Au	0191	0034	0060	-0216	0241	-0103	-0116	-0376	-0111	-0276
15. DsgRp	-0203	-0532	-0012	0379	-0082	-0146	0372	0483	-0127	0614
16. Con-Vb	0230	0003	0053	-0080	0236	0122	-0212	0198	-0008	-0238
17. RWd	-0094	0385	0214	0277	0090	0097	-0332	0357	0171	-0475
18. PNum	0599	0102	-0201	0178	-0178	0001	0250	0217	0166	0076
19. Map-Vb	0117	0128	0090	0018	0087	0082	-0064	-0509	0162	-0215
20. Map-Rc	-0263	-0321	0043	-0131	0085	-0253	0470	-0401	-0182	0236
21. SenSp	-0264	-0081	0063	0184	-0095	0263	-0295	0214	0061	0177
22. PSyl-2	-0041	-0041	0078	0114	0108	0131	0001	-0028	-0032	-0067
23. RFig	-0230	-0352	0016	0396	0132	-0130	0274	0340	-0310	0219
24. Rel	0006	0195	0232	-0174	0282	-0255	-0021	-0129	-0053	-0476
25. SComp	-0256	0061	0160	-0305	0085	-0212	0182	-0036	-0148	-0146
26. InsSp	-0329	-0025	0147	0010	-0039	0258	-0284	-0051	-0249	0063
27. PWd-R	0051	0049	0032	0271	-0314	0235	-0319	-0162	0286	0265
28. IComp	-0001	-0091	0081	-0133	0195	-0390	0235	0216	-0148	-0104
29. MPrin	0249	0426	0124	-0085	-0385	0280	0204	0258	0131	-0041
30. RCon	0290	-0133	0004	0212	0255	0092	-0232	-0847	-0252	-0122
31. CCoord		-0165	-0200	0005	-0078	-0009	-0148	0276	0237	0243
32. AReas	-0165		0151	-0018	0080	-0267	-0043	0137	0321	0869
33. RdComp	-0200	0151		0350	0058	0141	-0211	-0063	-0070	-0209
34. Voc	0005	-0018	0350		-0016	0090	0102	0175	-0043	0033
35. DTRd	-0078	0080	0058	-0016		0318	0121	-0097	-0354	0200
36. SpaO-1	-0009	-0267	0141	0090	0318		-0206	0323	0690	-0051
37. CRd	-0148	-0043	-0211	0102	0121	-0206		-0281	-0093	-0078
38. DRTime	0276	0137	-0063	0175	-0097	0323	-0281		-0161	-0040
39. SpaO-2	0237	0321	-0070	-0043	-0354	0690	-0093	-0161		0033
40. NumOp	0243	0869	-0209	0033	0200	-0051	-0078	-0040	0033	

TABLE C-9

Complete Factor Matrix F_1

(Decimal points omitted)

Test	A_1	B_1	C_1	D_1	E_1	F_1	G_1	H_1	I_1	J_1	K_1	h_1^2
1. Lim	70	-06	-09	-06	09	01	10	35	-06	01	-08	67
2. LSp-Vi	33	04	08	-10	25	59	00	-04	00	-17	07	57
3. PSyl-1	29	04	-02	-17	04	23	50	-10	-37	09	-05	58
4. Con-NV	33	09	08	-12	-10	05	05	22	02	06	17	23
5. NSp-Au	24	14	-00	06	21	65	-01	02	01	03	10	56
6. PWd-U	27	-10	-06	10	06	19	55	-04	09	31	12	56
7. RSyl	36	-02	01	-00	-03	01	24	-21	14	-06	08	26
8. Ideas	48	-13	-02	-07	09	04	08	38	08	23	11	48
9. Map-Rp	22	21	25	-04	-13	02	30	07	05	-08	21	33
10. NSp-Vi	27	20	-04	-06	07	62	07	03	00	-08	02	52
11. Pict	31	13	10	-05	11	10	16	08	09	-12	24	26
12. Para	55	02	-02	-08	-16	-00	08	-20	16	05	11	42
13. Num	16	24	-03	01	-17	18	27	-15	03	08	32	35
14. LSp-Au	38	07	05	-05	26	62	05	-09	03	02	-02	61
15. DsgRp	20	15	32	35	-28	23	14	20	-05	-12	18	53
16. Con-Vb	41	00	-10	-07	07	01	26	24	15	-07	-16	36
17. RWd	11	15	-09	-13	07	11	46	02	33	23	-02	45
18. PNum	23	07	01	-07	-02	20	63	-07	02	02	-01	50
19. Map-Vb	11	06	12	02	-04	14	22	09	11	-12	06	14
20. Map-Rc	27	10	32	17	-25	16	22	-05	09	-10	28	45
21. SenSp	50	-05	-01	01	-02	34	-12	07	-04	19	-21	47
22. PSyl-2	35	07	09	-12	-12	29	46	-07	-14	-15	02	51
23. RFig	29	-04	14	17	-17	07	28	06	21	-06	09	30
24. Rel	30	38	10	12	-12	08	12	10	-08	-02	28	38
25. SComp	44	03	00	-12	-00	-03	49	25	16	-11	-03	56
26. InsSp	12	07	05	-07	-01	32	-03	11	-13	-33	-09	28
27. PWd-R	30	05	01	-08	04	07	59	05	25	-12	-04	54
28. IComp	28	27	39	20	09	01	05	01	-09	-04	-03	36
29. MPrin	30	19	23	51	16	-04	-05	04	07	10	-09	48
30. RCon	-07	04	10	22	55	01	-03	-08	02	-02	-04	38
31. CCoord	14	26	29	19	38	02	02	04	-00	-03	20	40
32. AReas	54	44	-10	37	-03	03	-01	-01	04	-00	-08	64
33. RdComp	74	11	07	25	03	-04	-09	-07	-05	-03	-02	64
34. Voc	80	-07	05	-11	04	03	-10	-05	-16	00	00	70
35. DTRd	29	65	27	-12	03	-01	-01	-01	01	05	03	60
36. SpaO-1	17	29	56	-23	02	04	-01	07	-03	-01	06	49
37. CRd	24	60	36	-03	-06	-02	-02	-01	08	07	-12	58
38. DRTime	25	34	21	-08	25	-01	09	00	03	01	20	34
39. SpaO-2	28	27	48	17	-08	-01	-01	-06	02	-08	07	43
40. NumOp	35	64	-17	-25	-00	-01	02	02	-05	-04	05	63

TABLE C-10

Factor Matrix F_2

(Decimal points omitted)

Test	A_2	B_2	C_2	D_2	E_2	F_2	G_2	H_2	I_2	J_2	K_2	h_2^2
1. Lim	64	-36	-07	-00	03	-25	-13	20	-08	-03	-00	68
2. LSp-Vi	47	-05	04	-13	35	39	-15	-05	09	-11	-04	56
3. PSyl-1	43	-15	-08	-23	00	19	23	-17	-42	10	06	58
4. Con-NV	36	-01	05	-12	-10	-06	-07	17	03	07	16	23
5. MSp-Au	42	03	-08	02	38	44	-11	05	06	04	05	55
6. PWd-U	41	-24	-09	-04	03	12	47	-08	01	27	08	56
7. RSyl	37	-10	00	01	-13	01	15	-22	09	-11	-03	26
8. Ideas	46	-29	01	-02	03	-17	-02	33	09	23	09	50
9. Map-Rp	39	18	18	-16	-20	05	19	04	05	00	11	34
10. MSp-Vi	46	04	-15	-13	25	44	-10	08	05	-04	-02	53
11. Pict	43	05	06	-07	-00	04	05	05	03	-08	-19	25
12. Para	49	-11	-10	-04	-15	-13	-04	-26	19	01	07	41
13. Num	32	18	-10	-08	-20	23	16	-11	04	05	23	34
14. LSp-Au	52	-07	-02	-01	35	43	-10	-08	07	05	05	61
15. DsgRp	39	20	28	13	-26	27	02	19	-10	-01	-02	47
16. Con-Vb	43	-21	-10	-07	02	-15	12	21	04	-10	-13	35
17. RWd	29	-02	-18	-12	-00	07	44	01	26	18	10	43
18. PNum	44	-09	-05	-21	-09	19	44	-08	-05	05	11	50
19. Map-Vb	24	03	08	-07	-07	13	15	08	04	-11	-00	13
20. Map-Rc	42	13	27	-01	-21	16	11	-05	10	-05	-14	38
21. SenSp	47	-23	-05	07	13	11	-30	-02	-00	22	14	47
22. PSyl-2	53	-06	-01	-26	-09	25	20	-10	-21	-09	-09	53
23. RFig	39	-09	19	03	-20	04	18	05	13	-07	-00	30
24. Rel	45	28	03	11	-22	12	01	08	-07	03	21	41
25. SComp	53	-18	-07	-15	-06	-13	36	20	01	-16	-07	56
26. InsSp	20	03	02	-12	07	27	-20	12	-12	-27	-10	29
27. PWd-R	47	-12	-05	-18	-07	01	45	02	12	-17	-07	53
28. IComp	39	29	25	15	09	-07	01	-01	-12	-04	-09	36
29. MPrin	33	18	24	52	13	-10	04	03	-00	08	15	53
30. RCon	-02	11	13	25	47	-03	15	-06	-00	-07	-03	35
31. CCoord	28	33	20	14	37	-10	13	02	-04	-05	-20	45
32. AReas	58	25	-27	42	-08	-08	-07	-00	-02	-04	-11	68
33. RdComp	65	-05	06	34	-04	-18	-22	-16	-03	-05	-01	66
34. Voc	66	-24	02	-01	04	-22	-33	-18	-09	-03	-03	70
35. DTRd	46	59	-08	-14	05	-17	-07	-02	-02	06	05	63
36. SpaO-1	32	40	32	-33	06	-10	-17	01	01	08	07	51
37. CRd	40	55	06	-01	-07	-12	-07	00	09	10	21	55
38. DRTime	38	32	04	-08	16	-11	08	-02	02	06	15	32
39. SpaO-2	38	36	38	06	-11	-06	-07	-06	04	-01	-06	45
40. NumOp	45	40	-46	-11	-05	-13	-11	02	-04	-07	-05	63

TABLE C-11

Factor Matrix F_3

Final Unrotated Orthogonal Factor Matrix

(Decimal points omitted)

Test	A_3	B_3	C_3	D_3	E_3	F_3	G_3	H_3	I_3	J_3	K_3	h_3^2
1. Lim	587	-380	003	184	-033	-326	-160	179	-098	-034	-105	709
2. LSp-Vi	484	-089	015	-087	477	203	-163	-033	120	-106	-130	589
3. PSyl-1	451	-238	-096	-254	037	106	095	-215	-430	137	-146	628
4. Con-NV	359	-019	044	-084	-090	-121	-136	155	064	091	104	227
5. NSp-Au	443	-030	-097	042	483	299	-063	082	070	048	118	563
6. PWd-U	424	-335	-042	-100	-030	114	411	-094	019	264	162	591
7. RSyl	369	-135	029	-012	-164	045	094	-221	081	-147	-214	316
8. Ideas	423	-315	077	084	-015	-263	-034	306	102	246	-173	555
9. Map-Rp	429	153	133	-257	-191	039	082	044	062	016	002	342
10. NSp-Vi	486	-050	-184	-102	377	295	-129	111	070	-037	-008	548
11. Pict	439	022	054	-082	001	-006	000	049	030	-080	-162	239
12. Para	462	-139	-080	052	-189	-105	-084	-258	231	-012	176	446
13. Num	361	106	-131	-171	-171	275	071	-090	077	067	175	347
14. LSp-Au	534	-129	-038	019	473	267	-075	-066	086	035	-125	632
15. DsgRp	419	208	275	-021	-170	302	-067	190	-102	032	232	521
16. Con-Vb	411	-266	-059	013	-046	-200	086	189	-020	-109	-042	342
17. RWd	319	-134	-191	-182	-055	028	402	027	231	149	-177	462
18. PNum	475	-198	-054	-309	-090	137	307	-088	-073	043	079	505
19. Map-Vb	263	-002	082	-143	-041	099	092	103	037	-122	180	175
20. Map-Rc	443	127	244	-121	-168	174	021	-030	106	-035	-177	391
21. SenSp	436	-241	-015	206	182	029	-294	-029	020	227	094	473
22. PSyl-2	559	-156	-017	-320	-036	185	021	-114	-222	-058	-079	548
23. RFig	396	-101	230	-037	-223	081	095	057	105	-054	130	321
24. Rel	475	259	003	028	-194	171	-038	105	-076	052	-092	391
25. SComp	534	-267	-038	-146	-156	-169	251	193	-047	-177	119	580
26. InsSp	211	008	002	-110	191	171	-260	139	-145	-243	044	292
27. PWd-R	496	-221	-037	-245	-127	-029	341	021	068	-202	004	536
28. IComp	400	320	210	128	059	-054	048	-027	-150	-028	-137	374
29. MPrin	324	246	273	498	043	-009	191	033	-027	090	-122	550
30. RCon	-008	141	131	226	383	-043	304	-068	-032	-102	138	364
31. CCoord	305	351	172	122	293	-121	254	021	-046	-055	072	436
32. AReas	571	206	-246	489	-163	062	010	037	-038	-056	130	721
33. RdComp	604	-014	113	456	-102	-101	-169	-178	-029	-070	066	677
34. Voc	606	-221	058	198	015	-271	-354	-237	-043	-026	142	737
35. DTRd	488	545	-220	-060	014	-208	-046	-026	-026	064	007	639
36. SpaO-1	351	425	183	-310	107	-245	-144	-024	029	100	245	597
37. CRd	427	527	-057	010	-081	-118	-033	011	064	085	-109	509
38. DRTime	404	288	-038	-053	109	-158	109	-041	025	045	093	312
39. SpaO-2	405	414	311	010	-099	-041	-075	-077	054	-009	-221	507
40. NumOp	462	293	-548	003	-086	-141	-119	036	-038	-081	-094	659

TABLE C-12

Final Residual Correlation Matrix R₃

(Decimal points omitted)

Test	1	2	3	4	5	6	7	8	9	10
1. Lim		-0124	-0250	0109	-0057	0128	0040	0023	-0141	0166
2. LSp-Vi	-0124		-0151	0523	-0137	0307	-0460	-0263	0193	0022
3. PSyl-1	-0250	-0151		-0101	0213	0173	-0245	-0106	0129	0297
4. Con-NV	0109	0523	-0101		-0327	0540	0031	0077	0399	0142
5. NSp-Au	-0057	-0137	0213	-0327		-0162	0302	0265	-0096	-0180
6. PWd-U	0128	0307	0173	0540	-0162		0289	0121	0035	0006
7. RSyl	0040	-0460	-0245	0031	0302	0289		-0352	-0330	-0045
8. Ideas	0023	-0263	-0106	0077	0265	0121	-0352		0379	0161
9. Map-Rp	-0141	0193	0129	0399	-0096	0035	-0330	0379		0104
10. NSp-Vi	0166	0022	0297	0142	-0180	0006	-0045	0161	0104	
11. Pict	-0395	-0074	-0181	0245	0297	0414	-0188	0049	-0104	-0199
12. Para	0162	0298	0333	-0268	-0248	-0100	0162	0341	0203	0095
13. Num	0132	-0091	0229	0025	-0173	-0540	0372	0579	-0039	-0106
14. LSp-Au	0253	-0391	-0306	-0405	0370	0242	-0043	-0338	0040	-0058
15. DsgRp	0180	0292	0263	-0383	-0356	-0622	0528	0097	0002	-0267
16. Con-Vb	-0454	-0063	0042	-0138	-0026	-0234	-0123	-0319	-0249	-0267
17. RWd	-0259	-0366	-0681	-0332	-0087	0306	-0470	-0501	0109	0283
18. PNum	0238	0257	-0089	-0060	-0172	-0154	-0051	-0172	0115	-0345
19. Map-Vb	0255	-0105	0474	-0109	0012	-0840	0859	0595	0114	0573
20. Map-Rc	0177	0187	-0129	0031	0295	0498	-0279	0114	-0132	-0095
21. SenSp	-0289	0273	0252	-0016	-0325	-0485	0297	0090	-0816	-0311
22. PSyl-2	-0143	-0120	-0075	-0181	-0103	-0241	-0115	-0006	-0008	0034
23. RFig	-0006	0086	0144	0143	0035	-0421	0979	-0000	0125	-0539
24. Rel	-0094	-0206	-0387	0508	0289	0856	-0175	-0131	-0201	0019
25. SComp	0390	-0086	0392	-0542	0278	0025	0151	0166	-0353	-0208
26. InsSp	-0197	0029	-0347	-0067	-0135	0185	-0383	-0319	0079	0078
27. PWd-R	-0335	0058	0028	0036	-0236	-0032	-0373	-0122	-0214	0314
28. IComp	0190	-0244	-0329	-0048	0118	0664	-0018	-0506	-0257	-0114
29. MPrin	-0239	-0228	-0065	-0458	0016	0004	-0890	-0169	0171	0201
30. RCon	-0120	0344	0235	0270	-0412	-0024	0223	0224	0192	-0017
31. CCoord	0378	0086	-0056	0199	-0024	-0313	0660	0635	-0014	-0023
32. AReas	0069	0324	0367	0107	-0442	-0478	0025	0153	0341	0297
33. RdComp	-0146	-0093	-0078	0044	0028	0065	0052	0076	-0102	0044
34. Voc	0243	0034	0048	-0089	0050	-0281	0279	0177	0396	-0036
35. DTRd	-0026	-0067	0223	-0201	-0015	-0175	0232	-0006	-0029	-0253
36. SpaO-1	0021	-0055	0360	-0296	-0537	-0526	0123	0280	-0019	0259
37. CRd	-0018	-0230	-0121	-0330	0372	0042	0188	-0324	-0480	0082
38. DRTime	-0045	0410	-0013	0231	0301	-0171	0033	-0192	-0105	-0424
39. SpaO-2	-0313	-0170	-0194	0239	0052	0257	-0752	-0473	0175	0310
40. NumOp	0014	0029	-0249	0206	0059	0264	-0144	-0038	0186	-0128

TABLE C-12 (Continued)

Final Residual Correlation Matrix R₃

(Decimal points omitted)

Test	11	12	13	14	15	16	17	18	19	20
1. Lin	-0395	0162	0132	0253	0180	-0454	-0259	0238	0255	0177
2. LSp-Vi	-0074	0298	-0091	-0391	0292	-0063	-0366	0257	-0105	0187
3. PSyl-1	-0181	0333	0229	-0306	0263	0042	-0681	-0089	0474	-0129
4. Con-NV	0245	-0268	0025	-0405	-0383	-0138	-0332	-0060	-0109	0031
5. NSp-Au	0297	-0248	-0173	0370	-0356	-0026	-0087	-0172	0012	0295
6. PWd-U	0414	-0100	-0540	0242	-0622	-0234	0306	-0154	-0840	0498
7. RSyl	-0188	0162	0372	-0043	0528	-0123	-0470	-0051	0859	-0279
8. Ideas	0049	0341	0579	-0338	0097	-0319	-0501	-0172	0595	0114
9. Map-Rp	-0104	0203	-0039	0040	0002	-0249	0109	0115	0114	-0132
10. NSp-Vi	-0199	0095	-0106	-0058	-0267	-0267	0283	-0345	0573	-0095
11. Pict		0351	0876	-0588	0456	-0153	-0536	-0415	-0724	0142
12. Para	0351		0055	0156	-0497	0369	0071	-0319	-0402	0174
13. Num	0876	0055		0108	0021	-0429	0225	-0414	0017	0357
14. LSp-Au	-0588	0156	0108		0416	-0053	-0406	0182	0048	-0133
15. DsgRp	0456	-0497	0021	0416		0361	0936	-0327	-0668	-0206
16. Con-Vb	-0153	0369	-0429	-0053	0361		0321	-0228	0483	-0398
17. RWd	-0536	0071	0225	-0406	0936	0321		0260	0067	-0728
18. PNum	-0415	-0319	-0414	0182	-0327	-0228	0260		-0007	-0044
19. Map-Vb	-0724	-0402	0017	0048	-0668	0483	0067	-0007		0564
20. Map-Rc	0142	0174	0357	-0133	-0206	-0398	-0728	-0044	0564	
21. SenSp	0238	-0368	-0002	0048	0005	0651	0449	0301	-0136	-0446
22. PSyl-2	-0249	0026	-0136	-0157	0189	0457	0406	0278	0122	-0168
23. RFig	0749	-0572	-0870	0338	-0109	-0131	0325	0184	-0482	-0043
24. Rel	0066	0421	0639	-0287	0167	0113	-0792	-0502	0416	0152
25. SComp	0088	-0142	-0113	0486	-0221	0063	0063	-0128	-0232	0350
26. InsSp	0172	0106	-0266	-0108	-0006	0021	0327	0333	-0563	-0313
27. PWd-R	-0039	-0055	0172	-0139	-0119	0125	-0087	0066	-0024	-0264
28. IComp	-0006	-0048	-0055	-0080	0403	-0258	-0190	-0051	0022	-0183
29. MPrin	-0389	0494	-0144	-0311	0419	0100	-0222	0494	-0064	-0203
30. RCon	0327	-0221	0271	-0070	-0392	0049	0351	-0724	0239	0100
31. CCoord	0499	-0122	0244	0141	-0080	-0145	-0249	0353	-0004	0111
32. AReas	-0231	-0373	-0448	0158	-0746	0110	0489	0137	-0080	0090
33. RdComp	-0140	-0181	0184	0050	-0191	0076	0254	-0280	-0070	0138
34. Voc	0287	-0301	-0258	0019	-0004	-0201	0460	-0053	-0303	0022
35. DTRd	0034	-0122	-0422	0420	-0193	0219	0268	-0235	0162	0183
36. SpaO-1	-0050	-0464	-0124	0405	-0693	0284	0626	-0274	-0231	0184
37. CRd	-0523	0085	-0585	-0015	0259	0007	-0202	0465	0172	0002
38. DRTime	0596	-0029	0315	-0181	0083	0120	0385	-0072	-0633	-0229
39. SpaO-2	-0804	0617	0010	-0327	0455	-0076	-0339	0303	0557	-0445
40. NumOp	0161	0065	0347	-0242	0370	-0334	-0466	0228	-0148	-0096

TABLE C-12 (Continued)

Final Residual Correlation Matrix R$_3$

(Decimal points omitted)

Test	21	22	23	24	25	26	27	28	29	30
1. Lin	-0289	-0143	-0006	-0094	0390	-0197	-0335	0190	-0239	-0120
2. LSp-Vi	0273	-0120	0086	-0206	-0086	0029	0058	-0244	-0228	0344
3. PSyl-1	0252	-0075	0144	-0387	0392	-0347	0028	-0329	-0065	0235
4. Con-NV	-0016	-0181	0143	0508	-0542	-0067	0036	-0048	-0458	0270
5. NSp-Au	-0325	-0103	0035	0289	0278	-0135	-0236	0118	0016	-0412
6. PWd-U	-0485	-0241	-0421	0856	0025	0185	-0032	0664	0004	-0024
7. RSyl	0297	-0115	0979	-0175	0151	-0383	-0373	-0018	-0890	0223
8. Ideas	0090	-0006	-0000	-0131	0166	-0319	-0122	-0506	-0169	0224
9. Map-Rp	-0816	-0008	0125	-0201	-0353	0079	-0214	-0257	0171	0192
10. NSp-Vi	-0311	0034	-0539	0019	-0208	0078	0314	-0114	0201	-0017
11. Pict	0238	-0249	0749	0066	0088	0172	-0039	-0006	-0389	0327
12. Para	-0368	0026	-0572	0421	-0142	0106	-0055	-0048	0494	-0221
13. Num	-0002	-0136	-0870	0639	-0113	-0266	0172	-0055	-0144	0271
14. LSp-Au	0048	-0157	0338	-0287	0486	-0108	-0139	-0080	-0311	-0070
15. DegRp	0005	0189	-0109	0167	-0221	-0006	-0119	0403	0419	-0392
16. Con-Vb	0651	0457	-0131	0113	0063	0021	0125	-0258	0100	0049
17. RWd	0449	0406	0325	-0792	0063	0327	-0087	-0190	-0222	0351
18. PNum	0301	0278	0184	-0502	-0128	0333	0066	-0051	0494	-0724
19. Map-Vb	-0136	0122	-0482	0416	-0232	-0563	-0024	0022	-0064	0239
20. Map-Rc	-0446	-0168	-0043	0152	0350	-0313	-0264	-0183	-0203	0100
21. SenSp		0108	0326	-0219	-0530	0148	0375	0396	0352	0059
22. PSyl-2	0108		-0009	-0117	-0428	0240	0006	-0290	0134	0202
23. RFig	0326	-0009		0194	-0297	0084	0057	0203	0245	-0157
24. Rel	-0219	-0117	0194		-0014	-0206	-0262	-0282	-0838	0344
25. SComp	-0530	-0428	-0297	-0014		0244	0110	0265	0052	-0129
26. InsSp	0148	0240	0084	-0206	0244		-0112	0382	0353	-0055
27. PWd-R	0375	0006	0057	-0262	0110	-0112		0213	0336	-0103
28. IComp	0396	-0290	0203	-0282	0265	0382	0213		-0536	0123
29. MPrin	0352	0134	0245	-0838	0052	0353	0336	-0536		0211
30. RCon	0059	0202	-0157	0344	-0129	-0055	-0103	0123	0211	
31. CCoord	-0567	-0062	-0309	0638	-0727	-0472	-0211	-0274	-0236	-0040
32. AReas	-0028	0192	-0315	-0096	-0238	0020	0136	0109	0644	-0301
33. RdComp	-0180	0114	-0304	0180	0198	0163	-0033	0107	0049	-0074
34. Voc	-0240	0136	-0159	0191	-0346	-0042	-0018	-0021	0014	0022
35. DTRd	0014	0027	0245	0375	0136	-0031	-0275	0257	-0224	0241
36. SpaO-1	0155	0326	-0515	0003	-0087	0264	0326	0092	0687	-0248
37. CRd	0261	0059	0288	-0594	0569	-0001	-0051	0387	0181	-0089
38. DRTime	-0282	-0106	0119	0357	-0116	-0118	-0221	0237	0125	-0668
39. SpaO-2	0402	-0109	-0160	-0552	0350	-0051	0320	-0316	-0108	0017
40. NumOp	0165	-0154	0239	-0312	-0127	-0008	0142	-0347	-0143	0160

TABLE C-12 (Continued)

Final Residual Correlation Matrix R₃

Final Residual Correlation Matrix R_3

(Decimal points omitted)

Test	31	32	33	34	35	36	37	38	39	40
1. Lim	0378	0069	-0146	0243	-0026	0021	-0018	-0045	-0313	0014
2. LSp-Vi	0086	0324	-0093	0034	-0067	-0055	-0230	0410	-0170	0029
3. PSyl-1	-0056	0367	-0078	0048	0223	0360	-0121	-0013	-0194	-0249
4. Con-NV	0199	0107	0044	-0089	-0201	-0296	-0330	0231	0239	0206
5. NSp-Au	-0024	-0442	0028	0050	-0015	-0537	0372	0301	0052	0059
6. PWd-U	-0313	-0478	0065	-0281	-0175	-0526	0042	-0171	0257	0264
7. RSyl	0660	0025	0052	0279	0232	0123	0188	0033	-0752	-0144
8. Ideas	0635	0153	0076	0177	-0006	0280	-0324	-0192	-0473	-0038
9. Map-Rp	-0014	0341	-0102	0396	-0029	-0019	-0480	-0105	0175	0186
10. NSp-Vi	-0023	0297	0044	-0036	-0253	0259	0082	-0424	0310	-0128
11. Pict	0499	-0231	-0140	0287	0034	-0050	-0523	0596	-0804	0161
12. Para	-0122	-0373	-0181	-0301	-0122	-0464	0085	-0029	0617	0065
13. Num	0244	-0448	0184	-0258	-0422	-0124	-0585	0315	0010	0347
14. LSp-Au	0141	0158	0050	0019	0420	0405	-0015	-0181	-0327	-0242
15. DsgRp	-0080	-0746	-0191	-0004	-0193	-0693	0259	0083	0455	0370
16. Con-Vb	-0145	0110	0076	-0201	0219	0284	0007	0120	-0076	-0334
17. RWd	-0249	0489	0254	0460	0268	0626	-0202	0385	-0339	-0466
18. PNum	0353	0137	-0280	-0053	-0235	-0274	0465	-0072	0303	0228
19. Map-Vb	-0004	-0080	-0070	-0303	0162	-0231	0172	-0633	0557	-0148
20. Map-Rc	0111	0090	0138	0022	0183	0184	0002	-0229	-0445	-0096
21. SenSp	-0567	-0028	-0180	-0240	0014	0155	0261	-0282	0402	0165
22. PSyl-2	-0062	0192	0114	0136	0027	0326	0059	-0106	-0109	-0154
23. RFig	-0309	-0315	-0304	-0159	0245	-0515	0288	0119	-0160	0239
24. Rel	0638	-0096	0180	0191	0373	0003	-0594	0357	-0552	-0312
25. SComp	-0727	-0238	0198	-0346	0136	-0087	0569	-0116	0350	-0127
26. InsSp	-0472	0020	0163	-0042	-0031	0264	-0001	-0118	-0051	-0008
27. PWd-R	-0211	0136	-0033	-0018	-0275	0326	-0051	-0221	0320	0142
28. IComp	-0274	0109	0107	-0021	0257	0092	0387	0237	-0316	-0347
29. MPrin	-0236	0644	0049	0014	-0224	0687	0181	0125	-0108	-0143
30. RCon	-0040	-0301	-0074	0022	0241	-0248	-0089	-0668	0017	0160
31. CCoord		-0332	-0154	-0006	-0359	-0473	-0470	0428	0285	0419
32. AReas	-0332		-0076	-0267	-0161	-0323	0031	-0261	0894	0179
33. RdComp	-0154	-0076		0043	0156	0115	-0238	-0014	0035	-0176
34. Voc	-0006	-0267	0043		-0187	-0384	0041	0156	0108	0220
35. DTRd	-0359	-0161	0156	-0187		-0039	0369	-0375	-0344	-0143
36. SpaO-1	-0473	-0323	0115	-0384	-0039		0164	-0146	0941	0100
37. CRd	-0470	0031	-0238	0041	0369	0164		-0510	-0337	-0211
38. DRTime	0428	-0261	-0014	0156	-0375	-0146	-0510		-0139	0131
39. SpaO-2	0285	0894	0035	0108	-0344	0941	-0337	-0139		-0240
40. NumOp	0419	0179	-0176	0220	-0143	0100	-0211	0131	-0240	

TABLE C-13

Oblique Transformation Matrix A

(Decimal points omitted)

	Factor										
	A	B	C	D	E	F	G	H	I	J	K
A_3	22	18	26	30	25	20	08	10	25	13	20
B_3	-27	43	67	-21	-33	-07	-04	-18	28	19	02
C_3	02	-81	17	-22	11	-04	02	01	51	14	06
D_3	32	23	-46	-30	-17	-14	-17	11	28	63	03
E_3	-12	-11	01	09	-11	73	04	09	-44	33	-28
F_3	-17	05	-39	35	-34	40	05	-21	47	-08	56
G_3	-29	-02	-06	53	14	-34	-07	-05	01	57	04
H_3	-60	20	09	-33	54	10	-25	53	02	-03	48
I_3	25	-12	11	19	00	13	-91	-02	03	-27	-19
J_3	13	-01	24	41	-56	-27	15	76	-11	-04	21
K_3	46	-01	07	03	-18	-16	-19	-17	-33	12	51

TABLE C-14

Rotated Oblique Factor Matrix V

(Decimal points omitted)

Test		A	B	C	D	E	F	G	H	I	J	K
						Factor						
1.	Lim	19	02	-06	-10	48	06	09	32	01	05	-04
2.	LSp-Vi	03	-04	02	20	09	66	01	-01	02	-00	-06
3.	PSyl-1	00	01	-03	41	03	09	58	06	-02	-00	06
4.	Con-NV	11	03	23	01	16	-00	-06	19	03	-11	16
5.	NSp-Au	05	12	-01	27	-06	57	-03	10	-05	16	21
6.	PWd-U	19	-08	-08	64	02	-10	05	17	-05	14	25
7.	RSyl	13	-05	-07	21	16	01	03	-16	24	-02	-11
8.	Ideas	06	-06	06	05	35	-01	-08	54	00	-01	03
9.	Map-Rp	-04	-0C	35	19	15	-04	-00	-01	25	-10	18
10.	NSp-Vi	-03	18	01	26	06	59	-00	05	-03	-03	16
11.	Pict	-04	03	16	09	22	15	03	02	18	-01	00
12.	Para	51	04	05	20	02	-07	-16	-10	03	-08	-00
13.	Num	11	18	14	36	-11	01	-02	-11	15	-10	31
14.	LSp-Au	09	02	-05	33	-02	61	05	08	04	11	01
15.	DsgRp	-00	02	22	02	02	04	05	02	43	05	55
16.	Con-Vb	03	05	-03	05	44	01	-02	15	-04	05	03
17.	RWd	-09	09	06	53	15	-04	-13	16	-02	-01	00
18.	PNum	03	-03	05	53	15	-00	16	-03	02	-01	21
19.	Map-Vb	-01	-03	10	11	18	07	-07	-09	09	-00	24
20.	Map-Rc	-03	-08	21	16	11	08	-00	-06	46	-07	12
21.	SenSp	38	01	-08	10	-08	24	04	28	-03	03	12
22.	PSyl-2	-00	-01	06	34	17	20	35	-08	12	-12	15
23.	RFig	14	-14	06	14	21	-07	-11	-02	28	00	26
24.	Rel	-07	26	22	07	03	01	10	07	39	03	28
25.	SComp	02	03	05	19	53	-08	-01	04	-03	05	18
26.	InsSp	-10	05	00	-14	16	41	12	-11	03	-09	14
27.	PWd-R	-01	-03	04	36	43	-00	-04	-10	04	01	07
28.	IComp	-05	07	28	-06	04	04	16	00	32	30	-00
29.	MPrin	04	06	07	-04	-04	-08	-02	15	44	55	07
30.	RCon	-01	-06	-01	03	-06	11	-05	-11	-05	52	-08
31.	CCoord	-07	06	31	03	03	09	-00	-02	09	48	-01
32.	AReas	25	54	-01	01	-01	-06	-06	-00	28	36	28
33.	RdComp	48	09	-03	-09	04	-02	02	-02	31	28	05
34.	Voc	60	-04	03	-06	10	08	10	03	-01	03	-08
35.	DTRd	00	47	58	03	-06	-01	05	02	03	10	-02
36.	SpaO-1	08	-01	70	-02	-04	04	02	02	-04	-05	04
37.	CRd	-04	35	52	00	-05	-04	-02	06	24	08	00
38.	DRTime	06	18	39	14	00	02	-01	02	-01	18	00
39.	SpaO-2	-02	-01	43	-07	01	01	03	-04	48	07	-05
40.	NumOp	-00	67	26	02	08	05	04	-01	-07	-04	-03

TABLE C-15

Cosines of Angles Between Reference Vectors: Matrix A'A

(Decimal points omitted)

Factor

	A	B	C	D	E	F	G	H	I	J	K
A	1.00	-16	-15	11	-36	-18	-16	-16	-12	-01	-10
B	-16	1.00	07	-02	-12	-04	00	04	-11	11	17
C	-15	07	1.00	-04	-03	-12	-04	16	-02	-14	-05
D	11	-02	-04	1.00	-30	03	03	07	-11	03	13
E	-36	-12	-03	-30	1.00	06	-15	01	00	-07	-06
F	-18	-04	-12	03	06	1.00	-04	-11	-08	-11	-08
G	-16	00	-04	03	-15	-04	1.00	03	-01	09	01
H	-16	04	16	07	01	-11	03	1.00	-15	01	21
I	-12	-11	-02	-11	00	-08	-01	-15	1.02	11	29
J	-01	11	-14	03	-07	-11	09	01	11	1.00	03
K	-10	17	-05	13	-06	-08	01	21	29	03	1.01

TABLE 1

Intercorrelations of Primary Factors: Matrix TT'

(Decimal points omitted)

	Factor										
	A	B	C	D	E	F	G	H	I	J	K
A	1.00	25	19	02	43	26	28	18	20	22	02
B	25	1.00	-05	11	21	07	09	09	24	-13	-22
C	19	-05	1.00	03	13	16	09	-14	-01	17	12
D	02	11	03	1.00	28	-04	03	-02	16	-04	-17
E	43	21	13	28	1.00	06	25	03	11	03	00
F	26	07	16	-04	06	1.00	09	13	11	11	04
G	28	09	09	03	25	09	1.00	02	08	-07	00
H	18	09	-14	-02	03	13	02	1.00	25	-04	-26
I	20	24	-01	16	11	11	08	25	1.00	-13	-36
J	02	-13	17	-04	03	11	-07	-04	-13	1.00	06
K	02	-22	12	-17	00	04	00	-26	-36	06	1.00

APPENDIX D

Factor Analysis of Reference Tests

TABLE D-1

Correlations of 13 Tests for 442 Subjects: Matrix R_o

(Decimal points omitted)

Test	28 IC	29 MP	30 RCon	31 CC	32 AR	33 RComp	34 Voc
28. Instrument Comprehension		3047	1404	2924	2922	3232	1996
29. Mechanical Principles	3047		2489	3192	4516	3993	1666
30. Rudder Control	1404	2489		3028	0326	0462	-0322
31. Complex Coordination	2924	3192	3028		1924	1843	0968
32. Arithmetic Reasoning	2922	4516	0326	1924		5445	3463
33. Reading Comprehension	3232	3993	0462	1843	5445		6109
34. Vocabulary	1996	1666	-0322	0968	3463	6109	
35. Dial and Table Reading	3533	1780	0517	2744	3812	2792	2114
36. Spatial Orientation I	2572	1392	0180	2373	0486	1476	1850
37. Coordinate Reading	3701	2859	-0061	2262	3588	2339	1647
38. Discrimination Reaction Time	2664	1949	0454	3350	2276	2058	2104
39. Spatial Orientation II	3465	3154	0146	2892	3140	3073	2054
40. Numerical Operations	1462	0408	-0866	1537	4776	2343	2672

TABLE D-1 (Continued)

Correlations of 13 Tests for 442 Subjects: Matrix R_o

(Decimal points omitted)

	Test	35 DTR	36 SO_1	37 CR	38 DRT	39 SO_2	40 NO
28.	Instrument Comprehension	3533	2572	3701	2664	3465	1462
29.	Mechanical Principles	1780	1392	2859	1949	3154	0408
30.	Rudder Control	0517	0180	-0061	0454	0146	-0866
31.	Complex Coordination	2744	2373	2262	3350	2892	1537
32.	Arithmetic Reasoning	3812	0486	3588	2276	3140	4776
33.	Reading Comprehension	2792	1476	2339	2058	3073	2343
34.	Vocabulary	2114	1850	1647	2104	2054	2672
35.	Dial and Table Reading		4448	5725	3619	3291	5196
36.	Spatial Orientation I	4448		3853	3228	4247	2051
37.	Coordinate Reading	5725	3853		2761	3812	3911
38.	Discrimination Reaction Time	3619	3228	2761		2277	2901
39.	Spatial Orientation II	3291	4247	3812	2277		1543
40.	Numerical Operations	5196	2051	3911	2901	1543	

TABLE D-2

Final Matrix of Residual Correlations: Matrix R_5

(Decimal points omitted)

Test	28 IC	29 MP	30 RCon	31 CC	32 AR	33 RComp	34 Voc
28. Instrument Comprehension		-0487	-0008	-0244	0063	0350	0221
29. Mechanical Principles	-0487		0239	-0186	0306	-0009	-0329
30. Rudder Control	-0008	0239		-0013	-0239	-0110	-0134
31. Complex Coordination	-0244	-0186	-0013		0110	0164	0097
32. Arithmetic Reasoning	0063	0306	-0239	0110		0222	0202
33. Reading Comprehension	0350	-0009	-0110	0164	0222		0372
34. Vocabulary	0221	-0329	-0134	0097	0202	0372	
35. Dial and Table Reading	0199	-0103	0404	-0100	0027	0486	-0064
36. Spatial Orientation I	-0461	0178	0054	0019	0305	0033	0046
37. Coordinate Reading	0124	0307	0141	0208	-0388	-0191	-0104
38. Discrimination Reaction Time	0149	0110	-0668	0266	0223	-0151	-0084
39. Spatial Orientation II	-0193	-0125	-0514	0462	0493	-0120	-0159
40. Numerical Operations	-0156	-0383	-0425	0108	0430	0170	0434

TABLE D-2 (Continued)

Final Matrix of Residual Correlations: Matrix R$_5$

(Decimal points omitted)

Test	35 DTR	36 SO$_1$	37 CR	38 DRT	39 SO$_2$	40 NO
28. Instrument Comprehension	0199	-0461	0124	0149	-0193	-0156
29. Mechanical Principles	-0103	0178	0307	0110	-0125	-0383
30. Rudder Control	0404	0054	0141	-0668	-0514	-0425
31. Complex Coordination	-0100	0019	0208	0266	0462	0108
32. Arithmetic Reasoning	0027	0305	-0388	0223	0493	0430
33. Reading Comprehension	0486	0033	-0191	-0151	-0120	0170
34. Vocabulary	-0064	0046	-0104	-0084	-0159	0434
35. Dial and Table Reading		0172	0255	-0233	-0217	0093
36. Spatial Orientation I	0172		-0106	0238	0578	0139
37. Coordinate Reading	0255	-0106		-0092	-0275	0062
38. Discrimination Reaction Time	-0233	0238	-0092		-0081	0035
39. Spatial Orientation II	-0217	0578	-0275	-0081		0041
40. Numerical Operations	0093	0139	0062	0035	0041	

TABLE D-3

Unrotated Centroid Factor Matrix F_o

(Decimal points omitted)

Test	A_o	B_o	C_o	D_o	E_o	h^2
28. Instrument Comprehension	543	153	-169	039	090	36
29. Mechanical Principles	519	-071	-459	069	024	49
30. Rudder Control	160	129	-364	-149	-235	25
31. Complex Coordination	480	272	-276	-174	-280	49
32. Arithmetic Reasoning	625	-453	-092	377	-160	77
33. Reading Comprehension	612	-491	-119	-166	193	69
34. Vocabulary	481	-420	134	-329	178	57
35. Dial and Table Reading	672	191	338	156	-108	64
36. Spatial Orientation I	484	394	215	-127	239	51
37. Coordinate Reading	625	164	179	313	126	56
38. Discrimination Reaction Time	493	133	107	-147	-141	31
39. Spatial Orientation II	554	150	-088	060	277	42
40. Numerical Operations	492	-107	413	185	-293	54

Factor

TABLE D.-4

Oblique Transformation Matrix A

(Decimal points omitted)

Factor	A	B	C	D	E
A_o	23	25	29	33	35
B_o	30	-53	-18	-16	58
C_o	-68	10	-51	51	04
D_o	-33	-72	73	50	34
E_o	-53	35	30	-60	65

TABLE D-5

Rotated Oblique Factor Matrix V

(Decimal points omitted)

Test	Factor				
	A	B	C	D	E
28. Instrument Comprehension	23	04	27	03	34
29. Mechanical Principles	37	08	45	-03	16
30. Rudder Control	50	-04	03	-09	-09
31. Complex Coordination	59	-02	02	06	07
32. Arithmetic Reasoning	03	06	54	52	-02
33. Reading Comprehension	03	59	26	02	-01
34. Vocabulary	-09	66	-04	02	-07
35. Dial and Table Reading	-01	-05	07	51	34
36. Spatial Orientation I	-00	11	-06	-00	52
37. Coordinate Reading	-10	-09	33	35	51
38. Discrimination Reaction Time	20	12	-09	21	11
39. Spatial Orientation II	07	10	31	-02	48
40. Numerical Operation	-11	-01	-00	66	-00

TABLE D-6

Intercorrelations of primary vectors: Matrix TT'

(Decimal points omitted)

Factor	A	B	C	D	E
A	1.01	30	-02	32	35
B	30	1.00	15	46	32
C	-02	15	1.00	-04	-37
D	32	46	-04	1.01	37
E	35	32	-37	37	1.01